Digitized by Arya Samaj Foundation Chennai and eGangotri

JOURNAL OF
THE ROYAL
STATISTICAL
SOCIETY

VOL. 117
1954

CC-0. Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Si
Ac
Per

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

JOURNAL

OF THE

ROYAL

STATISTICAL SOCIETY

SERIES A (GENERAL)

CHECKED 1973
Initial ...

Founded 1834

Incorporated by Royal Charter 1887

Vol. 117—1954

LONDON :
ROYAL STATISTICAL SOCIETY
21 BENTINCK STREET, W.1

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ROYAL STATISTICAL SOCIETY

Patron—HER MAJESTY THE QUEEN.

COUNCIL AND OFFICERS.—1953-54.

Honorary Vice-Presidents
(having filled the Office of President)

THE RT. HON. VISCOUNT SAMUEL, G.C.B., G.B.E., D.C.L.
SIR ARTHUR L. BOWLEY, C.B.E., D.LITT., SC.D., D.SC., F.B.A.
H. LEAK, C.B.E.
THE RT. HON. LORD BEVERIDGE, K.C.B., LL.D., D.SC., F.B.A.
ERNEST CHARLES SNOW, C.B.E., D.SC.
THE RT. HON. LORD WOOLTON, P.C., C.H., D.L., LL.D.
*DAVID HERON, D.SC.
*SIR GEOFFREY HEYWORTH.
*PROFESSOR A. BRADFORD HILL, C.B.E., F.R.S., D.SC., PH.D.

President
SIR RONALD FISHER, F.R.S.

Vice-Presidents

PROFESSOR G. A. BARNARD.
E. C. FIELLER.
PHILIP LYLE.
F. YATES, F.R.S., SC.D.

Other Members of Council

PROFESSOR R. G. D. ALLEN, O.B.E.
F. J. ANSCOMBE.
W. R. BUCKLAND, PH.D.
H. CAMPION, C.B., C.B.E.
PROFESSOR D. G. CHAMPERNOWNE.
STELLA V. CUNLIFFE.
IRIS DOUGLAS.
D. J. FINNEY, SC.D.
R. F. FOWLER, C.B.E.
R. F. GEORGE.
R. G. GLENDAY, M.C.
J. O. IRWIN, SC.D., D.SC.
G. H. JOWETT.
JOAN E. KEEN.
PROFESSOR M. G. KENDALL, SC.D.
W. P. D. LOGAN, M.D.
SIR GEORGE MADDEX, K.B.E., F.I.A.
F. A. A. MENZLER, C.B.E., F.I.A.
C. A. MOSER.
DENNIS NEWMAN.
E. D. VAN REST.
J. RYAN, C.B.E., M.C.
L. G. K. STARKE, F.I.A.
A. W. SWAN.
L. T. WILKINS.
J. WISHART, D.SC.

Executive Committee

THE PRESIDENT.
THE EX-PRESIDENT
THE VICE-PRESIDENTS.
THE HON. SECRETARIES.
THE HON. TREASURER.
J. O. IRWIN, SC.D., D.SC.,
SIR GEORGE MADDEX, K.B.E., F.I.A.
F. A. A. MENZLER,, C.B.E. F.I.A.

Honorary Treasurer
R. F. FOWLER, C.B.E.

Honorary Secretaries and Editors
R. F. GEORGE.
PHILIP LYLE.
IRIS DOUGLAS.

Honorary Foreign Secretary
R. F. GEORGE.

Secretary
UNA M. CROKER.

Librarian
J. A. KING.

Bankers
ROYAL BANK OF SCOTLAND (DRUMMOND'S BRANCH), CHARING CROSS, LONDON, S.W.1.

Offices
21, BENTINCK STREET, LONDON, W.1.
(Telephone: WELBECK 7638)

* Also Member of Council.

519.905
R81J
V.117
पुस्तकालय विज्ञान भवन
विषय सं० 519.905
पुस्तक सं०... 1825
आ. पं. सं०... 1255
V.117

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

110635
Digitized by Arya Samaj Foundation Chennai and eGangotri

CONTENTS

VOL. 117—YEAR 1954

Part 1, 1954

	PAGES
Statistics of Statutory Marketing in West Africa, 1939–51. By P. T. BAUER	1–20
Discussion on the Paper	20–30
An Essay on the Mathematical Theory of Freedom. By DENIS and ANDRÉ GABOR	31–60
Discussion on the Paper	60–72
Length of Life of Musicians. By MILTON DA SILVA RODRIGUES	73–79
International Statistical Institute, 28th Session, Rome, 1953	80–84
Regional Economic Statistics. By K. S. LOMAX	85–101
Reviews of Books	102–117
Statistical and Current Notes	118–120
Obituary:	
W. T. Russell	121
Statistical and Economic Articles in Recent Periodicals	122–126
Additions to Library	127–131

Part 2, 1954

	PAGES
Cinemas and Cinema-Going in Great Britain. By H. E. BROWNING and A. A. SORRELL	133–165
Discussion on the Paper	165–170
The Demand for Motor Cars in the United States. By M. J. FARRELL	171–193
Discussion on the Paper	194–201
Pairing of Observations in Ordered Samples from a Normal Population. By D. R. READ, P. G. SMITH and J. H. INCE	202–204
Wholesale Prices in 1953. By THE EDITOR OF "THE STATIST"	205–209
Medicine and Medical Services in the United Kingdom. By B. BENJAMIN	210–232
Review of Books	233–244
Statistical and Current Notes	245–248
Statistical and Economic Articles in Recent Periodicals	249–252
Additions to Library	253–259
Periodical Returns: Bank of England Weekly Return, 1953	260–261

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Part 3, 1954

	PAGES
World Supply and Requirements of Farm Products. By COLIN CLARK	263–291
Discussion on the Paper	291–296
The Outlines of the Road Goods Transport Industry. By K. F. GLOVER and D. N. MILLER	297–323
Discussion on the Paper	324–330
Heights and Weights of the Army Intake, 1951. By S. ROSENBAUM	331–347
The Statistics of Education. By DORIS M. LEE	348–360
Reviews of Books	361–367
Statistical and Current Notes	368–370
Statistical and Economic Articles in Recent Periodicals	371–375
Additions to Library	376–381
Periodical Returns: Registration of the United Kingdom and Eire, 1949–1953	382–385

Part 4, 1954

	PAGES
Callbacks and Clustering in Sample Surveys: An Experimental Study. By J. DURBIN and A. STUART	387–418
Discussion on the Paper	418–428
The Phenomenon of Labour Turnover. By H. SILCOCK	429–440
The Relations between Chained Indexes of Input, Gross Output and Net Output. By P. H. KARMEL	441–458
The Mode of a Grouped Distribution. By H. M. FINUCAN	459
First International Conference of National Committees on Vital and Health Statistics	460–462
Annual Report of the Council	463–480
Proceedings of the One Hundred and Twentieth Annual General Meeting	481
Reviews of Books	482–496
Statistical and Current Notes	497–499
Obituary:	
Sir Henry Clay	500–501
A. M. Southall	501
Statistical and Economic Articles in Recent Periodicals	502–505
Additions to the Library	506–511
Periodical Returns: Revenue of the United Kingdom, 1953	512
Index to Vol. 117 (1954)	513–516

NOTICE

THE Council of the Royal Statistical Society wish it to be understood that the Society is not responsible for the statements or opinions expressed in the Papers read before the Society or published in its *Journal*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

VOL. 117.] [PART I

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART I, 1954.

Statistics of Statutory Marketing in West Africa, 1939–51*

By P. T. Bauer

[Read before the Royal Statistical Society, November 18th, 1953, The President Professor Sir Ronald Fisher, F.R.S., in the Chair]

Introduction

A few remarks may perhaps be in order to explain how I came to examine the operations of the marketing boards summarized in this paper.

In 1949 I was commissioned by the Colonial Office to enquire into the structure and organisation of West African trade, with special reference to monopolistic tendencies. For the last four years I have been engaged on this investigation. The scope of such an enquiry is necessarily different for the private sector of an economy and for the sector controlled by statutory monopolies. In the sphere of the former, the principal topics of a discussion of monopolistic tendencies are the degree of concentration, the factors influencing entry and the resulting market situation. When we come to consider the sector controlled by statutory monopolies these topics are irrelevant, since the degree of concentration is 100 per cent. and entry is barred by statute. On the other hand a review of the operations of these organizations becomes an appropriate subject of enquiry.

1

The four West African colonies of Nigeria, the Gold Coast, Sierra Leone and the Gambia have about half the population of the British Colonial Empire. Some three-quarters of all exports and about nine-tenths of non-mineral exports of this group of colonies are in the hands of marketing boards which are statutory export monopolies. These bodies handle all exports of cocoa, groundnuts, palm kernels, palm oil, cotton and of several minor products. These crops account for virtually a hundred per cent. of all agricultural exports produced by the African population of these colonies. In 1951 the f.o.b. values of these exports was about £200 million.

The West African marketing boards are by far the largest statutory export monopolies in the British Colonial Empire and possibly in the Commonwealth; they are indeed among the most important statutory export monopolies in the world. Already their financial resources on both current and capital account exceed those of the West African governments; and the disposal of their large reserves will be a major influence on the political and economic situation in these territories.

But quantitative information alone does not convey adequately the significance of these organizations. Their operations have far reaching influence on the wellbeing of these territories. Their decisions in fixing the prices paid to producers are a major factor in determining the level of incomes and the standard of living of the local populations. Through their influence on the flow of incomes these decisions largely affect the balance of payments of these colonies. By prescribing the prices received by producers they exercise a potent influence on the production of different crops. The results and repercussions of their policies, including some unintended results, can be expected to extend well into the future, particularly since their operations affect the future scale of output.

* The author is indebted to Mr. B. S. Yamey for help in the preparation of an early draft of this paper.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This paper presents the principal statistics up to the end of 1951* of the operation of the Gold Coast Cocoa Marketing Board and of the four boards operating in Nigeria, that is the Nigeria Cocoa Marketing Board, the Nigeria Groundnut Marketing Board, the Nigeria Oil Palm Produce Marketing Board, and the Nigeria Cotton Marketing Board.† The present marketing boards were established in 1947 (Cocoa) and 1949 (other products) when they took over from another statutory monopoly, the West African Produce Control Board, which had operated since the early days of the war, so that the West African producers have been affected by statutory marketing continuously since that time. As there was a large measure of continuity in producer price policy throughout the operation of statutory marketing, it is necessary to review the activities and price policies of the West African Produce Control Board, as well as those of the marketing boards which succeeded it.‡

To avoid unintended inferences and conclusions from the discussion, two points need to be stressed at the outset. First, the years covered by the discussion were to some extent the experimental or formative period of the present marketing boards. This does not affect the description of the policies, nor the analysis of their effects; indeed, it serves to bring out more clearly some of the problems created by an experimental *ad hoc* approach. But in a critical assessment of the decisions taken, it is relevant that over this period the boards could be said to be feeling their way; and further, as will be suggested below, they have had to do so without a clearly defined mandate. Secondly, this paper deals with policies actually pursued over the relevant period. It is not a discussion of stabilization measures as such, though in the concluding section there are a few remarks on this more general issue.

2

Statutory control of cocoa marketing dates back to 1939. To avert a threatened collapse of local cocoa prices following a partial closure of export markets after the outbreak of war, the British Government undertook to purchase all West African cocoa offered for sale at annually fixed prices. This guarantee was coupled with the establishment of a statutory export monopoly for handling the crop which was entrusted first to the Cocoa Control of the Ministry of Food, was transferred in 1940 to the newly established West African Cocoa Control Board which operated under the auspices of the Colonial Office. In 1942 this organization was somewhat enlarged and was renamed the West African Produce Control Board on taking over the marketing of groundnuts and oil palm produce when an expansion of supplies of these became of great importance after the loss of the Far East. This organization received statutory export monopoly powers for all the crops under its control. Thus cocoa was taken over by a statutory export monopoly because the market had contracted; and the system was extended to other products because of a sudden expansion of demand. In fact, neither circumstance postulated an export monopoly. A collapse of local cocoa prices could always be averted without a monopoly if the government was prepared to act as residual buyer and to give an unequivocal assurance to offer a minimum price for the crop; and this does not require a statutory monopoly. Similarly an export monopoly was clearly unnecessary to secure increased supplies of groundnuts and of oil palm produce. This aspect of the introduction of statutory marketing is of some interest as the wartime establishment of export monopolies in West Africa has come to be taken so much for granted that the grounds for it do not appear to have been examined; and the present marketing boards grew directly out of these arrangements.

Exports of West African cocoa were sold by the controlling authorities partly to the Ministry of Food and partly in other markets, very largely in North America. The prices paid by the

* Up to the end of the crop year 1950–51 or the calendar year 1951, the last complete year for which published figures are available at the time of writing (April 1953).

† These boards control about 95 per cent. by value of all exports subject to statutory marketing. There are three other minor boards: The Gold Coast Agricultural Products Marketing Board, the Sierra Leone Agricultural Marketing Board, and the Gambia Oilseeds Marketing Board. In all essentials their operations are identical with those of the boards discussed.

‡ There was here an asymmetry between the position of the boards and that of their constituents. The present boards came into being in 1947 and 1949; but the producers have been affected by statutory marketing continuously since the establishment of cocoa control in 1939 and the West African Produce Control Board in 1942.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Ministry of Food were determined first by the prices ruling in the United Kingdom in 1940; and thereafter by a formula which resulted in prices paid being somewhat below those received on sales to North America; the difference was of the general order of approximately 10–15 per cent. off c.i.f. prices for the period 1939–40 to 1946–47, the last year in which cocoa was handled by the West African Produce Control Board. As the authorities had a statutory monopoly of export they were in a position to prescribe producer prices at levels unrelated to market prices or to sale proceeds and thus to accumulate surpluses. About three-eights of the net f.o.b. proceeds of cocoa were withheld from the producers from 1939 to 1947.

The entire exportable supplies of the other products handled by the West African Produce Control Board were sold to the Ministry of Food. The sales were effected at cost prices, that is, at the prices paid to the producers plus charges to c.i.f. U.K.; and these prices bore no relation either to market prices or to those paid by the Ministry to other bulk suppliers of these products from Empire sources.

In this sphere the introduction of statutory marketing had some striking results. Some of these may be gauged from Table 1 which shows the relation between the c.i.f. values in the United Kingdom of Nigerian and Indian groundnuts respectively in those years in which the Nigerian product was sold by merchants (1939–41) and in those in which it was handled by the West African Produce Control Board.*

TABLE 1

Imports of Groundnuts into the United Kingdom, 1939–48

	From Nigeria		*From India*			
	Quantity 000 *tons* *a*	*c.i.f. value* £ *per ton* *b*	*Quantity* 000 *tons* *c*	*c.i.f. value* £ *per ton* *d*	b *as %* *of* (d)	
1939	41	10·4	209	11·0	95	Nigerian exports by merchants.
1940	123	14·7	247	15·8	93	
1941	214	17·3	377	18·1	96	
1942	201	17·3	253	20·4	85	*
1943	96	19·8	292	35·9	55	Nigerian exports by W.A.P.C.B.
1944	169	22·6	312	35·6	63	
1945	154	24·6	238	33·0	75	
1946	271	24·9	120	34·2	73	
1947	229	28·4	12	61·1	46	
1948	264	42·4	41	62·2	68	

* Statutory marketing introduced in West Africa in August 1942.
SOURCE.—Annual Statement of Trade of the United Kingdom.

As will be seen, the much higher prices paid for Indian groundnuts from 1942 were those paid for bulk supplies and not for marginal quantities.†

These figures do not suggest that the establishment of statutory marketing served to increase supplies, since the low prices secured and paid by the controlling authorities were hardly calculated to increase exports. They also cast some doubt on the suggestion that statutory marketing secures better export prices by eliminating weak selling by merchants.

* Substantially the same conclusions which emerge from the table also apply to the transactions of the West African Produce Control Board in oil palm produce. But for these commodities the statistics cannot be presented so conveniently, chiefly because the Ministry of Food did not purchase bulk supplies of these products both from West Africa and from other sterling sources. The relation between commercial values (as measured by the prices received by bulk suppliers of comparable commodities) and the proceeds realized by the West African Produce Control Board is discussed in sections 5 and 6.

† In 1947 and 1948 (the last two calendar years of the operation of the West African Produce Control Board) imports of groundnuts from India were comparatively small though they were not negligible. But by 1947 outside markets in groundnuts had revived and the prices c.i.f. Europe were appreciably higher than the c.i.f. values shown here, which are thus a conservative indication of market values.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The selling arrangements were modified in February 1947, and the prices paid by the Ministry of Food were no longer fixed by reference to costs of the West African Produce Control Board. Although the prices paid were still well below market levels, they were appreciably raised. But much of the increase was withheld by the West African Produce Control Board with the result that the prices received by the producers bore much the same relation to commercial values (that is, the local equivalent of market prices) as they did before the change; for groundnut producers this proportion was about two-fifths. Between February 1947, and April 1949, when its functions were transferred to the successor boards, the West African Produce Control Board accumulated some £11 million on exports of Nigerian and palm produce and about £10 million on exports of groundnuts.

Thus during these years the prices received by producers were below those received by other suppliers of the same or similar commodities on two counts; first, because the marketing authority received lower prices from the Ministry of Food than were paid to other bulk suppliers, and secondly, because of the retention of part of the sales proceeds from the producers.

3

Between 1944 and 1948 various government statements announced the official intention to continue statutory marketing after the war and to extend its range. The most important were those embodied in two White Papers on cocoa marketing* and an official Nigerian statement published as Nigerian Sessional Paper No. 20, of 1948†.

It would be inappropriate here to discuss at any length these easily accessible publications. In substance they stressed the desirability of the short period stabilization of producer prices and of the maintenance of statutory export monopolies as a device to secure this. The Nigerian government statement also referred to the need for price stabilization, but added certain further reasons for the maintenance and extension of statutory monopolies over the export of Nigerian produce. Among other reasons it emphasized that the maintenance of this form of marketing was also desirable, and indeed essential, because the accumulated surpluses could not be returned to the individual producers; and further because it would be regrettable to dissolve a going organization.

It will be noted that on the first of these arguments surpluses can never be returned to producers; but this applies with equal force to the funds of the marketing organizations proposed by the Sessional Paper.

The various official statements referred only in the vaguest terms to stabilization, and they did not deal with any of the difficult problems and ambiguities of this concept. In particular they did not consider the period over which the surpluses and deficits of the marketing organizations would balance; nor the relation between market prices and stabilized prices; nor the question of the maintenance of contact with a trend of market prices. They did not refer to the differences between stabilization of prices, incomes and real incomes. Indeed they did not discuss any of the problems of stabilization in a meaningful sense of the term. This omission in the official documents is important for an assessment of the policies which came to be pursued by the boards. They were not warned of the fundamental difficulties they were likely to encounter; and they were certainly not given a mandate sufficiently specific to serve as a guide to policy. Indeed, the documents announcing their establishment only obscured the difficulties of the problems of stabilization.

Local ordinances enacted in 1947 and 1949 established marketing boards to take over the handling of exports from the West African Produce Control Board. These newly constituted boards were henceforth to decide producer prices and future policy generally, both in the buying and selling of cocoa. The selling arrangements and the administrative and executive personnel of the West African Produce Control Board in London were left substantially unchanged, as were the buying arrangements in West Africa.

The functions and tasks of the marketing boards were laid down in purely general terms as the securing of the best arrangements for marketing the products under their control. It is note-

* *Report on Cocoa Control in West Africa* 1939–43 *and Statement on Future Policy*, Cmd. 6554 of 1944. *Statement on Future Marketing of West African Cocoa*, Cmd. 6950 of 1946.

† *Statement of the Policy Proposed for the Future Marketing of Nigerian Oils, Oilseeds and Cotton*, Lagos, 1948.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

worthy that although price stabilization was understood to be the principal purpose of establishing the marketing boards, there is no mention of this objective either in the Gold Coast or in the Nigeria Cocoa Marketing Ordinances; and it is mentioned only casually in a sub-clause in the other Nigerian ordinances, as one of the objects on which the funds of the Boards may be spent.

In Nigeria the boards consist of six members each—three officials and three nominated unofficial members; all six are appointed by the Governor and hold office at his pleasure. The three official members are the same for each of the boards while the unofficial members are different for each board. In the Gold Coast the Cocoa Marketing Board was repeatedly reconstituted by amending ordinances, and at present consists of nine members appointed by the Minister of Commerce, Industries and Mines. The producer prices prescribed by the Board must be approved by the Minister, who also has powers to direct the Board in the use or management of its funds.

The most important power of the boards is their sole right to export, and to buy for export the products under their control, including all processed products derived from these crops.

The boards purchase the crops through merchants whom they license as their buying agents. The powers of licencing extend beyond their own buying agents. Some of the boards have powers to licence all persons dealing in the products controlled by them. Technically they are empowered to licence even the pettiest village trader. The boards have many other extensive powers over producers, dealers and processors, not related to price policy.

4

Table 2 summarizes the operations of the marketing boards from their inception to the end of 1951.

TABLE 2

Summary of the Operations of the Marketing Boards, 1947–51

	Producer price per ton £ (1)	*F.o.b. cost per ton* £ (2)	*Average f.o.b. price per ton* £ (3)	*Surplus (inc. interest) per ton* £ (4)	*Surplus per ton as % of producer price (i.e., 4 as % of 1)* £ (5)	Total *annual surplus* £*m.* (6)
Gold Coast cocoa						
1947–48	75	85	201	117	183	24·1
1948–49	121	139	136	−0·5	−0·5	−0·1
1949–50	84	110	178	71	86	18·0
1950–51	130	196	269	77	59	20·1
Nigeria cocoa						
1947–48	63	70	195	126	200	9·3
1948–49	120	135	138	8	7	0·8
1949–50	100	117	178	69	69	6·9
1950–51	120	173	268	102	85	11·2
Nigerian palm oil						
1949	40	52	68	16	40	2·5
1950	40	52	65	13	32	2·1
1951	52	65	83	18	35	2·3
Nigerian palm kernels						
1949	26	33	45	12	46	3·2
1950	26	34	41	8	31	2·9
1951	32	41	57	16	50	5·4
Nigerian groundnuts						
1949–50	21	35	48	13	62	3
1950–51	21	41	63	24	114	3·3
Nigerian cotton						
1949–50	37	43	82	39	105	1·2
1950–51	37	56	107	51	138	2·2

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The figures in the table disregard any differences between market prices and the sales proceeds of the boards, a matter discussed in the next section. The surpluses are struck after the payment of export duties, which are included in the f.o.b. cost; a substantial part of the difference between columns 1 and 2 is represented by export duties. In practice the level of these duties is influenced by the size of the margins (surpluses) of the boards, since when these are large, export duties diminish only the margins per ton and do not directly affect producer prices. This made possible and indeed encouraged the sharp increases in the rates of export duties in recent years.* Both in its effects on the economy as a whole, and from the standpoint of the individual producer, an increase in export duty to transfer part of the surplus from a marketing board to the Government is purely a paper transaction which substitutes one type of compulsory levy for another.

Column 5 of the table shows at a glance the percentage by which producer prices in any one year could have been raised without drafts on reserves. Only in one instance was there a draft on reserves, and that was very small.

The aggregate surpluses are shown in Table 3.

TABLE 3

Surpluses of the Marketing Boards to the End of Crop Year 1950–51 *or Calender Year* 1951

	Taken over from the West African Produce Control Board £ *million*	*Surplus on operations* £ *million*	*Total surpluses* £ *million*
Gold Coast Cocoa Board . .	14	62	76
Nigeria Cocoa Board . . .	8	28	36
Nigeria Oil Palm Produce Board .	11	18	29
Nigeria Groundnut Board . .	10	6	16
Nigeria Cotton Board . . .	0·2*	3	3
	43	117	160

* Grant from Raw Cotton Commission.

These are official figures of the annually accruing surpluses. A minor part of these has been allocated (though usually not spent) for certain specific purposes, or to other organizations, and is therefore formally not part of the boards' reserves. For this reason the figures do not agree in every case with the published reserves of the boards.

5

There are certain other burdens on the producers of West African export crops relevant to this discussion.

There are heavy export duties on these products. As has been suggested in the preceding section, in recent years there was a connection between the surpluses of the boards and the rates of export duty, a high level of the former leading to an increase in the latter.

Differences between market prices and the sales proceeds realized by the marketing organizations need also to be examined. Where the former regularly exceed the latter and producers must sell to the statutory organizations, this difference must also be considered when assessing the effects of statutory marketing on producers.

The necessity for this procedure is obvious from the history of statutory marketing over a number of years. Until 1947 the Ministry of Food took over the crops from the West African Produce Control Board (with the exception of cocoa) at their cost price to the Board, which thus did not accumulate surpluses on these products. The prices received were much below those paid by the Ministry of Food for bulk supplies of these commodities from other sources; and they were also much below open market prices.

* In the Gold Coast export duty in 1950–51 was £51·1 per ton which was 39 per cent. of the basic producer price; in 1939–40 the figures had been £2·1 and 15 per cent. In Nigeria the increases were of the same order.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Examination of this matter is of interest for several reasons. First, in assessing the effects of statutory marketing it is necessary to consider the length of the period over which the prices received by producers have differed substantially from market prices or from those received by other suppliers. Both the length of the period and the extent of the difference are relevant. Secondly, the selling arrangements and results bear on the argument, frequently advanced on behalf of statutory export monopolies, that their position as strong sellers enables them to secure much more favourable prices than would be received by individual exporters. Further, in an assessment of the retention of a substantial proportion of the sales proceeds from producers over this period it is relevant that the proceeds (other than the proceeds of cocoa) were generally well below the market prices of the war and post-war years. It must however be noted that while computation of this item is of considerable interest, the interest is chiefly historical, since under selling arrangements which came into force at the end of 1951 the Ministry of Food pays open market prices for its bulk purchases of West African produce, so that this item does not, and indeed cannot, arise at present.

These differences between sales proceeds and commercial values as shown by open market prices or by the prices paid to other bulk suppliers are, of course, affected by the prices chosen for purposes of comparison. But it is clear that on sales of groundnuts and of oil palm produce these differences were large over most of the period of statutory marketing, chiefly over the period covered by the West African Produce Control Board.

Thus when discussing the effect of statutory marketing on producers, three items, or types of levy, must be considered; the surpluses of the marketing organizations; export duties; and the differences between commercial values and the sale proceeds realized. This last item is referred to in the discussion as under-realization. Although it cannot be computed and presented as precisely as can other items, it is possible to assess it closely for all major West African exports. But as this item is not in every respect *in pari materia* with the others, the three types of levy (the surplus of the marketing organizations, export duty and under-realization) are distinguished in all statistics presented in this paper to enable separate assessment to be made.

The basis of the calculations is discussed in the appendix to this paper, but an outline is necessary here as without it the tables may not be intelligible.

(*a*) The market prices and values with which the sales proceeds of the marketing organizations are compared refer in every case to prices paid for bulk supplies, and not for marginal quantities. In the marketing of groundnuts and oil palm produce over most of the period the prices are those paid by the Ministry of Food for bulk supplies of identical or closely similar commodities. From about 1948 some of these were no longer purchased by the Ministry of Food in significant quantities, but since that year consistent series of market prices are available relating to substantial transactions, and these serve as basis for comparison. As is well known, the principal vegetable oils and oilseeds are widely substitutable for each other in the production of edible fats and soap. Their prices are always inter-related, and usually move together closely. For this reason, changes in the market prices of any one oilseed are generally a reliable guide to changes in the market values of similar products, as long as substantial quantities of the principal oils and oilseeds are traded in the markets under review. West African vegetable oils and oilseeds are a small proportion of the total of such supplies reaching the market over a period; thus if they are sold on the open market they will fetch a price closely related to market quotations.

(*b*) For cocoa such comparisons require special care because the selling agencies of the marketing boards control such a large proportion of total world supplies that they necessarily influence world prices. Their sales tend to depress the market; and conversely when they do not sell prices tend to rise. It is thus generally not significant to compare the market prices received by them with the average daily or monthly market quotations which are often nominal. Nevertheless, from 1940 to 1948 a firm and meaningful comparison is possible between commercial values and the prices received by the marketing organizations. Over this period the price paid by the Ministry of Food for West African cocoa was based at first on the prices ruling in the United Kingdom when the distribution of cocoa was taken over by the Ministry of Food; and from 1942 it was based on a formula (explained in the first cocoa White Paper) which resulted in the Ministry obtaining its cocoa at a lower price than that ruling in the United States. The difference is significant between the c.i.f. New York price (converted at the official rate of exchange) and that paid by the Ministry

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of Food, since over most of this period the price of cocoa in the United States was controlled so that additional supplies could have been sold at the New York price.*

This price was controlled from 1941 to 1946; for the seasons over which it was not controlled one-third of the difference between the New York price and that paid by the Ministry of Food was taken in recognition of the fact that if more had been sold in New York the price there would have been lower. On a very modest estimate the differences in the aggregate exceeded £12 million on total imports of West African cocoa into the United Kingdom from 1940 to 1948 (private purchase of cocoa was restored in 1949). This is over £3 a ton on the total tonnage handled by the statutory marketing organizations from 1939–40 to 1950–51. A figure of £3 per ton has been adopted in the tables under the heading of *Under-realization* for the period as a whole. As approximately seven-eighths of the total dates from the operations of the West African Produce Control Board, no figures are shown under this heading for the period since 1947. In considering this item for cocoa it should be remembered that the British Government underwrote the purchase of the entire West African crop (though at an unspecified price) when in the early years of the war the market prospects appeared very bleak indeed.

(*c*) As a corollary of (*a*) and (*b*), the comparisons between commercial values and sales proceeds are not vitiated by the familiar objection that if larger amounts had been sold in higher-priced markets the prices there would have been lower. The considerations set out in (*a*) meet this objection for groundnuts and oil palm produce, and those in (*b*) meet it for cocoa.

(*d*) The discrepancies between market prices and selling prices considered in the discussion do not refer to unsuccessful forward sales in the accepted sense of the term. The great bulk refers to differences in prices paid for supplies sold on identical or closely similar conditions of delivery (usually spot or near deliveries), but paid for at different prices. This was the position for the crops purchased by the Ministry of Food from the West African Produce Control Board and from other sources. In recent years (up to 1951) the bulk sales of the Groundnut, Oil Palm Produce and Cotton Boards were also unsuccessful. Most of these transactions seem to have stemmed principally from the desire to make certain of a price showing an appreciable surplus on the producer price, especially perhaps over this formative period of the Boards' operations. This supposition is confirmed by the frequent references in the reports of the boards to surpluses as evidence of commercial success.

This conclusion probably does not apply with the same force to the bulk sales of the Groundnut Marketing Board and the Oil Palm Produce Marketing Board for 1951. The decision of these two boards to sell forward the entire exportable output under their control at prices which turned out to have been very unfortunate, may have been the result partly of an unfortunate judgment of market prospects, as well as of the desire to ensure sales at prices showing substantial margins on the producer prices.†

The inclusion of that year in the calculation of the under-realization would not greatly affect the rates of this levy, either over the period as a whole or since 1947. It has, nevertheless, been excluded from the calculation of the averages of the rates of levy to ensure that these should not be influenced by the inclusion of what may have been simply unsuccessful forward sales. The year is, however, included in the computation of the total levies over the period as a whole shown in Table 6. As the figures for that year (1950–51 or 1951) are shown separately in Tables 4 and 5, the under-realization for that year can be easily subtracted from the total if that is thought proper.

(*e*) The summary Table 6 shows the figures for the entire period of statutory marketing. In the more detailed tables they are shown both for the entire period of statutory marketing (beginning in 1939 for cocoa, 1942 for groundnuts and palm kernels and 1943 for palm oil), and also for certain sub-periods. These mark important changes in administrative and selling arrangements, such as the revision of the selling arrangements for groundnuts and oil palm produce in 1947,

* In outside markets prices ruling for substantial quantities were much higher than the New York prices.

† It was partly because of these unsuccessful sales that from the end of that year the selling arrangements were greatly altered. Since the end of 1951 the prices received by the boards from the Ministry of Food have been based on independently assessed and declared average market prices of the previous quarter.

This is an interesting tribute to the validity of market prices as a guide to commercial values. It incidentally confirms the validity and relevance of the use of market prices in the computation of the discrepancies between commercial values and the sales proceeds realized by the marketing organizations.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

or the change over from West African Produce Control Board to the present marketing boards. The present Cocoa Marketing Boards took over from the West African Produce Control Board in 1947 and the other boards in 1949. Surpluses were accumulated on cocoa from the earliest days of statutory marketing, but for reasons already stated for the other products the accumulation of surpluses began only in 1947. For cocoa the information is presented for the period as a whole, and separately for the period since 1947 (the inception of the present boards), and also separately for the last year. For groundnuts and oil palm produce the information is presented in the tables for the period as a whole, as well as separately from 1947 to 1951 (the period of the accumulation of surpluses); and also from 1949 to 1951 (the operation of the present boards); and again separately for the latest year.

The various changes in organization and in selling arrangements were sufficiently important to justify presentation of the information separately for sub-periods, in addition to showing it for the entire period of statutory marketing. But as will be seen, there was remarkable consistency in producer price policy over the period as a whole.

(*f*) The figures are shown both in unweighted and in weighted form. This presentation has been adopted to meet a familiar difficulty. Unweighted averages are required to show the varying rates of levies through time; and weighted figures to show the total amounts involved.*

In these series this difficulty is not important quantitatively because of the comparative consistency in producer price policy over the period as a whole, which is reflected in Tables 4 and 5 in the similarity of the figures of the levies for the period as a whole and the various sub-periods. But as a special check and as a matter of interest both the weighted and unweighted figures are shown. In Tables 4 and 5 the levies are expressed as averages (simple arithmetic mean) of annual amounts per ton and of percentages. In Table 6 they are shown as totals, that is, as the sums of annual amounts multiplied by tonnages; thus that table presents the information in a weighted form.

The results are closely similar to those obtained by the use of the simple arithmetic mean, which is remarkable in view of the large changes in the absolute amounts involved, and especially of the much larger absolute figures of recent years.

6

The relevant information is set out in Tables 4 to 6. Table 4 shows absolute figures, and Table 5 expresses these absolute figures as percentages of producer prices: of net available proceeds, i.e., as percentages of the amounts available to be shared between the Government, the boards and the producers; and of net commercial values, i.e., as percentages of the amounts available to be shared between the Government, the boards and the producers if commercial values had been realized.

Table 6 shows aggregates, that is, the sums of the annual amounts multiplied by the tonnages marketed annually.

The principal conclusions from these tables emerge clearly.

In round figures the surpluses of the boards and the export duties together totalled about £200 million over the whole of this period. Under-realization in the aggregate exceeded another £100 million. The total of the combined levies approximately equalled the total of gross proceeds as shown in Table 6.

In the most important single effect or aspect of statutory marketing, the relation of producer prices to market prices, there was over this period remarkable continuity of policy since the inception of this form of marketing. This is clear from the comparative consistency of the figures for individual products in column 9 of Table 5. For particular products these do not differ greatly for the period as a whole or for parts of the period. As selling prices improved a larger proportion was withheld from producers, leaving producer prices at about the same proportion of commercial values as before. This tendency was, for instance, evident in 1947 when, after the changes of the

* In more specific terms the dilemma might be put as follows. In recent years the absolute level of prices has been much higher than in the early years of statutory marketing. Thus if weighted averages are used the recent years would swamp the earlier period. On the other hand reliance on the simple arithmetic mean might give rise to the usual objections, in particular to the objection that the results present a misleading idea of the amounts involved.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Levies on the Producers of West African Exports under Statutory Marketing, 1939–51

(£'*s per ton*)

	Year	*Producer price* (1)	*Export Duty* (2)	*Surplus of Marketing Organization* (3)	*Net sales proceeds, i.e.,* (1) + (2) + (3)* (4)	*Under-realization* (5)	*Net commercial values, i.e.,* (4) + (5)† (6)
Gold Coast cocoa	1939–40 to 1950–51	46·7	7·2	27·5	81·4	3·0	84·4
	1947–48 to 1950–51	102·5	18·5	64·1	185·1	n.a.	185·1
	1950–51	130·0	51·1	72·7	253·8	‡	253·8
Nigerian cocoa	1939–40 to 1950–51	47·9	6·0	31·6	85·5	3·0	88·5
	1947–48 to 1950–51	100·6	14·1	71·8	186·5	n.a.	186·5
	1950–51	120·0	40·0	95·0	255·0	(‡)	255·0
Nigerian groundnuts	1942–43 to 1949–50	14·0	1·5	5·6	21·1	16·3	37·4
	1947–48 to 1949–50	18·8	3·1	14·9	36·8	16·1	52·9
	1949–50	21·2	3·3	13·0	37·5	18·0	55·5
	1950–51	21·2	6·4	22·0	49·6	17·0	66·6
Nigerian palm kernels	1942 to 1950	14·5	1·2	3·9	19·6	12·6	32·2
	1947 to 1950	22·15	2·15	8·75	33·05	14·35	47·4
	1949 to 1950	26·0	2·55	9·75	38·3	10·75	49·05
	1951	32·0	5·3	14·2	51·5	15·0	66·5
Nigerian palm oil	1943 to 1950	23·2	1·8	7·4	32·4	11·4	43·8
	1947 to 1950	34·0	2·9	14·8	51·7	12·9	64·6
	1949 to 1950	40·0	4·3	14·3	58·6	10·4	69·0
	1951	52·0	7·8	17·8	77·6	46·0	123·6

* I.e., sales proceeds f.o.b., less marketing expenses to f.o.b. other than export duty, that is amount available to be shared locally between the Government, the marketing organization and the producer.

† I.e., amount which would have been available to be shared locally between the Government, the marketing organization and the producer if market prices had been realized.

‡ Private purchase of cocoa restored in 1949.

n.a. Not available, or more precisely not computed; see text.

TABLE 5

Levies on Producers of West African Exports under Statutory Marketing, 1939–51

(*percentages*)

	Year	*Export Duty*	*Surplus*	*Under-realization*	*Total Levies, i.e.,* (1)+(2)+(3)	*Producer Price*	*Export Duty*	*Surplus*	*Duty and Surplus, i.e.,* (6)+(7)	*Producer Price*	*Export Duty*	*Surplus*	*Under-realization*	*Total Levies, i.e.,* (10)+(11)+(12)
		As Percentage of Producer Price (i.e., % of (1) in Table 4)				*As Percentage of Sales Proceeds (i.e., % of (4) in Table 4)*				*As Percentage of Commercial Values (i.e., % of (6) in Table 4)*				
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Gold Coast cocoa	1939–40 to 1950–51	15	59	6	81	57	9	34	43	55	9	33	4	45
	1947–48 to 1950–51	18	63	n.a.	81	55	10	35	45	55	10	35	n.a.	45
	1950–51	39	56	*	95	51	20	29	49	51	20	29	*	49
Nigerian cocoa	1939–40 to 1950–51	13	66	6	85	56	7	37	44	54	7	36	4	46
	1947–48 to 1950–51	14	71	n.a.	85	54	8	38	46	54	8	38	n.a.	46
	1950–51	33	79	*	112	47	16	37	53	47	16	37	*	53
Nigerian ground-nuts	1942–43 to 1949–50	11	40	116	167	66	7	27	34	37	4	15	44	63
	1947–48 to 1949–50	16	79	86	181	51	8	40	49	36	6	28	30	64
	1949–50	16	61	85	162	57	9	35	43	38	6	23	32	62
	1950–51	30	104	80	214	43	13	44	57	32	10	33	26	68
Nigerian palm kernels	1942 to 1950	8	27	87	122	74	6	20	26	45	4	12	39	55
	1947 to 1950	10	40	65	114	67	7	26	33	47	5	18	30	53
	1949 to 1950	10	37	41	89	68	7	25	32	53	5	20	22	47
	1951	17	44	47	108	62	10	28	38	48	8	21	23	52
Nigerian palm oil	1943 to 1950	8	32	49	89	72	6	23	28	53	4	17	26	47
	1947 to 1950	9	44	38	90	66	6	29	34	53	4	23	20	47
	1949 to 1950	11	36	26	73	68	7	24	32	58	6	21	15	42
	1951	15	34	88	138	67	10	23	33	42	6	14	37	85

* Private purchase of cocoa restored in 1949.

n.a. Not available, or more precisely, not computed, see text.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 6

Levies on the Producers of West African Exports under Statutory Marketing, 1939–51

(£m.)

	Producers' gross proceeds (1)	*Export duty* (2)	*Surplus* (3)	*Under-realization* (4)	*Total levies* (5)	*Levies as % of proceeds* (6)
Gold Coast cocoa .	138	22	77	8	107	71
Nigerian cocoa . .	58	7	37	3	47	81
Nigerian groundnuts .	33	4	16	36	56	170
Nigerian palm kernels .	55	6	17	42	65	118
Nigerian palm oil .	33	3	12	18	33	100

Notes.

Gross proceeds denotes the basic producer price multiplied by the tonnage marketed. The figures necessarily appreciably exceed producers total receipts since most of the output is sold at stations where lower prices apply.

In the text the under-realization in cocoa marketing is estimated at £12 million; of this £8½ million has been allotted to the Gold Coast and £3½ million to Nigeria in approximate proportion to the tonnage marketed. These figures have been rounded off to £8 million and £3 million.

selling arrangement of the West African Produce Control Board with the Ministry of Food, the Board received substantially higher prices than before and immediately began to withhold a large part of the increases in prices.

Producer prices were kept generally at between two-fifths to three-fifths of commercial values over the period as a whole and over the various sub-periods. For groundnut producers the proportions tended to be less, generally about one-third to two-fifths of commercial values.

This comparative consistency is of particular interest in the levies on cocoa and groundnut producers, since in these figures the element of estimate is very small indeed, and the risk of overestimate is negligible. Surpluses and export duties amounted to over 90 per cent. of the aggregate of the levies on cocoa producers as here computed; and for these two items official figures are available throughout the period. In the calculation of the levies on groundnut producers the element of estimate is also small for two reasons. First, in recent years the surplus of the Board represented most of the levies; and secondly, because under-realization can be assessed very closely indeed in view of the comparison between the prices paid (generally by the Ministry of Food) for Nigerian and Indian groundnuts.

7

In these tables the levies are related to the basic producer prices payable at ports or at railway line stations; to gross proceeds in the sense of basic producer prices multiplied by the tonnages marketed; to proceeds available at the points where the basic producer prices are payable; and to commercial values at these points. Thus the relation of the levies to the receipts of producers pivots on the basic prices. These prices necessarily substantially overstate producers' proceeds per ton, and overstate producer incomes per ton to an even greater extent. First, basic prices are port prices or railway line prices, and most producers necessarily sell at prices which are lower than these by transport costs* and the cost of the services of intermediaries. Secondly, expenses of production must be deducted from the prices received by the producers before arriving at their incomes from the sale of a ton of produce. Thus all percentages in the table substantially understate the levies as a proportion of producers' cash receipts, as a proportion of incomes available in their absence (i.e., as percentages of pre-tax incomes), and as percentages of retained incomes.

But even in relation to gross proceeds as here defined, the levies on the producers of groundnuts and palm kernels, the most important exports from northern and eastern Nigeria, were over

* With the exception of Gold Coast cocoa, lower producer prices are gazetted for buying stations other than those to which the basic prices used here refer. Most of the output is bought by the boards' licensed buying agents at such stations. The initial sale by producers is often at non-gazetted markets, still further from the ports or the railway line and at correspondingly lower prices.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

this period as a whole and over all sub-periods (with only one unimportant exception) at rates of over 50 per cent.

When the necessary adjustments are made to convert gross proceeds per ton at port or railway line prices to producer incomes, the proportions become significantly higher. Expressed as percentages of producer incomes available in their absence (i.e., as percentages of pre-tax incomes), the levies on the producers of every one of these crops averaged well over 50 per cent., both over this period as a whole and from 1947 to 1951. In 1950–51 they were again of that order.

The position of the groundnut producers deserves more detailed consideration. Disregarding the heavy under-realization, in the year 1950–51 export duty and the Board's surplus excluding interest amounted to about 57 per cent. of the disposable proceeds at railway line stations.* Without these levies the average cash incomes of groundnut producers in 1950–51 from the sale of groundnuts would have been of the general order of £10–£15 per year; after the levies they were about £4 or £5.†

The burden of these levies on the producers of the other major export crops was proportionately somewhat less,‡ though still necessarily at appreciably higher rates than suggested by the figures in the table.

8

The effects of statutory marketing on the position of West African producers relatively to producers of similar crops elsewhere is a matter of some interest.

Table 7 compares the increase in producer prices of groundnuts and oil palm produce between the mid-1930's and recent years with the changes in f.o.b. prices of identical or similar products from other sterling area sources; it is confined to groundnuts and oil palm produce as it is only for these products that a regular series of price quotations is available for bulk supplies from sterling sources over this period.§

In the table the letter "c" denoted a product controlled by one or other of the West African marketing boards and the letter "f" a free or uncontrolled product.

The figures show clearly the relatively deterioration of the position of the West African producers compared with that of their competitors. Those for groundnuts and palm kernels are particularly telling as they refer to identical commodities; the market values of Indian and West African groundnuts and of Malayan and Nigerian palm kernels are practically identical. It will be noted that the price received by Malayan producers of palm kernels has risen over ninefold between the mid-1930's and 1951 while the producer price in West Africa less than quadrupled.

9

Throughout the period of statutory marketing the West African producers have had to sell their crops at prices controlled below open market levels. But they have had to purchase the imported consumer goods on which they spend their incomes at open market prices which were governed by general forces of supply and demand, and which were rising substantially almost without interruption throughout this period. As a result the terms of trade of the producers were depressed

* The selling price was £70 c. and f. United Kingdom; total transport and marketing expenses, excluding export duty, were about £20, leaving £50 to be shared between the Government, the Board and the producer. The export duty and the Board's surplus amounted to about £28·5, and the producer price at these stations was £21·2. If interest is included in the Board's surplus the total of the two levies is raised to over £30, or more than 60 per cent. of sales proceeds.

† The basis of these figures is easily explained. In 1949–50 and 1950–51 the basic railway line price was £21·2 a ton; at road stations it ranged from £16·2 to £21. In money terms these were the highest prices for at least 25 years. Most producers cultivate altogether about three or four acres, and about one acre of this is under groundnuts; with their equipment and technique they could not cultivate much more. One acre of groundnuts yields about one-quarter of a ton. Thus if producers sell at gazetted stations and have no expenses, they are left with about £4–£5 for a season's production of groundnuts if the entire output is sold. There are unavoidable expenses of production and of transport, and net cash incomes from ground-nut production would be nearer to £3.

‡ The burden on the cotton producers was very similar to that of the groundnut producers, cf. Table 2.

§ This table is of some significance, and as the sources of the data are not easily accessible in every case, detailed explanatory notes are presented in the Appendix.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 7

Changes in Commodity Prices, 1935–37, 1948, 1949, 1950 *and* 1951

	1935–37	1948	1949	1950	1951
c Nigerian groundnuts (producer prices)					
£ per ton	6·9	17·9	20·4	21·2	30·1
As per cent. of 1935–37	*100*	*259*	*295*	*307*	*436*
c Gambia groundnuts (ex scale Bathurst)					
£ per ton	10·9	22·8	22·8	23·2	29·5
As per cent. of 1935–37	*100*	*210*	*210*	*213*	*271*
f Indian groundnuts (c.i.f. Europe, less freight rate)					
£ per ton	12·8	62·7	63·0	69·7	93·0
As per cent. of 1935–37	*100*	*489*	*492*	*545*	*727*
c Nigerian palm kernels (producer prices)					
£ per ton	8·1	19·7	25·1	25·1	31·0
As per cent. of 1935–37	*100*	*242*	*309*	*309*	*383*
f Malayan palm kernels (c.i.f. Europe, less freight rate)					
£ per ton	7·8	49·0	46·8	58·5	73·0
As per cent. of 1935–37	*100*	*628*	*600*	*750*	*936*
c Nigerian palm oil (producer prices) Weighted average of grades 1 to 3*					
£ per ton	12·0	31·2	40·0	40·0	52·0
As per cent. of 1935–37	*100*	*260*	*333*	*333*	*433*
Grade 2					
£ per ton	12·0	23·1	37·1	37·1	43·0
As per cent. of 1935–37	*100*	*192*	*309*	*309*	*358*
f Malayan palm oil (c.i.f. U.K., less freight rate)					
£ per ton	18·4	84·4	86·4	75·9	104·5
As per cent. of 1935–37	*100*	*459*	*470*	*410*	*568*

* See explanatory notes in the appendix.

far below what they would have been without this system, and well below those of their principal competitors. Indeed, with the important exception of the cocoa growers, the terms of trade of the producers were as late as 1950 less favourable than they had been in the mid-30's; and this may have applied even in 1951.*

The general conclusion is reasonably clear from the fact that producer prices of groundnuts and of oil palm produce were in 1950 about three times the level of the mid-30's while the prices of the general range of imported goods destined for purchase by Africans had risen more.

This is suggested even by two officially compiled indices of Nigerian import prices (available

* It has been suggested that comparison of the terms of trade of producers under statutory marketing with those in its absence may be affected by the fact that the international terms of trade may be influenced by the retention of part of the proceeds at one period and their release at a later period. This objection is undoubtedly valid when the elasticity of supply of imports is significantly lower during the accumulation of surpluses than during their disbursement; and this may be an important factor in certain circumstances. But for various reasons this interesting objection does not bear significantly on the particular comparison in the text. Of all staple imports, including those of textiles, West African imports were a small proportion of total world imports, so that it is unlikely that increased demand from West Africa would have significantly affected import prices. Again, in other sterling area countries expenditure was not so severely curtailed, so that supplies were diverted to these countries either by the play of market forces or in some instances by the allocation of supplies.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

for only a few years) which substantially understate the general rise in import prices, and understate much more the rise in up-country prices of imported comodoties:*

But while the general conclusion is clear, the presentation of detailed information on this topic raises certain difficulties. These arise from the fact that while indices of producer prices can be computed comparatively easily, the corresponding information on retail prices of imported merchandise is not available.

The problems of securing it stem from two distinct sources: first, the absence of a comprehensive index of import prices, and secondly, from the changes in the relation of import prices to retail prices. The second factor is important for the present discussion, since in West Africa practically throughout this period retail prices of most types of imported merchandise increased over pre-war levels proportionately much more than did c.i.f. values.†

These difficulties can be partially overcome, or rather by-passed, by a method which has been used at various times to express changes in the terms of trade of the West African producers; by relating producer prices to the prices of imported cotton piece goods, much the most important class of imported merchandise purchased by the West African producers.

Over the whole period of statutory marketing (1940–51) annual imports of cotton piece goods averaged 31 per cent. of all imports in Nigeria (simple arithmetic mean of annual percentages) and 21 per cent. in the Gold Coast; over the last five years (1947–51) the corresponding figures are 28 per cent. and 20 per cent. These percentages would be raised considerably if substantial classes of imports which are not trade goods in the accepted sense of the term are excluded.‡ But even without this adjustment, imports of cotton piece goods over this period were on the average about eight times the imports of any other single class of merchandise destined for purchase by the local population.§ Cotton piece goods figure particularly prominently in the purchase of the rural population; certain other types of imported merchandise of some importance such as cigarettes, sugar, flour, motor fuel, fuel oil and cement and corrugated iron sheets are bought relatively more by the urban population.

There is, however, an obvious disadvantage in the use of the prices of cotton piece goods in conjunction with producer prices as an index of the terms of trade of producers. Although cotton piece goods are much the most important type of merchandise bought by the West African producers, they are still only one class; and since the outbreak of war import prices of cotton piece goods have risen appreciably more than those of all merchandise imports.

But this objection or disadvantage is not so serious as it appears at first. Over this period retail prices rose proportionately much more than import prices or landed costs; and it is highly probable that at least until 1950 an index of the landed costs of cotton piece goods does not significantly overstate the rise since the war in the retail prices of imported merchandise bought by the African farmer. And although an index of the terms of trade of producers in terms of cotton piece goods by definition does not provide a comprehensive index, it does not present, at least until 1950, an unduly pessimistic picture of the terms of trade of producers in a more comprehensive sense.

* One of these is a series compiled in the Colonial Office based on twenty Nigerian imports; the other is a series which used to be compiled by the Department of Statistics in Nigeria and was discontinued in 1950. Both are heavily weighted by capital goods and by other commodities not ordinarily bought by the African population, the prices of which rose appreciably less over this period than did those of the general range of imported merchandise. But even on the basis of these indices, the terms of trade of the producers of groundnuts and of oil palm produce were as late as 1950 less favourable than they had been in 1935–37.

† The proportionately greater rise in retail prices was due to several reasons, of which the divergence between the open market prices and the formally or informally controlled prices of so-called short supply merchandise was the most important.

‡ Such as imports by government departments, imports of certain types of capital goods and of raw materials, imports by the mining companies and so forth.

§ Both in Nigeria and in the Gold Coast artificial silk piece goods were over this period quantitatively the next most important imported consumer goods; in both colonies imports of this commodity averaged (simple arithmetic mean of annual percentages) 3 per cent. over the period 1940–51; when weighted by annual values of imports the Nigeria percentage is raised to 4·7 per cent. very largely as a result of exceptionally heavy imports of this commodity in 1951. The proportionate changes in the unit import prices of artificial silk piece goods and cotton piece goods were very similar over this period, so that their growing importance in recent years serves to support rather than to invalidate the use of cotton piece goods for our purpose.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Apart from its value as an indicator of the terms of trade of producers in a more comprehensive sense, an index based on the prices of cotton piece goods is of interest for another reason. In West Africa this class of merchandise is the principal inducement good for stimulating production, including the maintenance and extension of the acreage under export crops. Thus the relation of producer prices to the prices of imported cotton piece goods is of considerable interest in its own right.

Table 8 shows indices (1935–37 = 100) of the ratios between the producer prices of the principal export crops and the landed costs* of cotton piece goods. The figures are shown for 1943 when they were at their lowest point; for 1945, the first year after the war; for 1947, which was the last year in which the West African Produce Control Board handled all these products, and for 1950 and 1951, the last two years for which the data are available.

TABLE 8

Indices of the Terms of Trade of the West African Producers in Terms of Imported Cotton Piece Goods

(1935–37 = 100)

	Gold Coast cocoa	*Nigerian cocoa*	*Nigerian groundnuts*	*Nigerian palm oil*	*Nigerian palm kernels*
1935–37 . . .	100	100	100	100	100
1943 . . .	24	25	47	32	35
1945 . . .	45	48	67	39	43
1947 . . .	87	82	67	56	56
1950 . . .	126	134	75	76	76
1951 . . .	123	152	88	72	77

There was a very marked deterioration in the terms of trade of producers during the war and the early post war years. Until about 1945–46 the producer prices of the principal crops were at about the level of the mid-1930's while the prices of imported textiles had doubled or trebled. There was sharp deterioration in the terms of trade of the producers and a large fall in the volume of imports.

There has been a great improvement since about 1947. But in terms of imported merchandise generally, the terms of trade of producers were as recently as 1949 and 1950 less favourable than they had been in the mid-1930's; and in terms of cotton piece goods this still applied in 1951.

There are several other statistical series which it would be possible to present on related aspects of the price policies of the marketing boards. Thus, for instance, it can be shown that the constriction of incomes has tended to diminish the share of West African imports in colonial imports relatively to the share of West African exports in total colonial exports. But the presentation of further statistics would amount very largely to the ringing of changes on the same theme or set of figures. Attention may however be drawn to a less obvious aspect of these policies which may be more fundamental in its long run repercussions.

The prolonged payment of producer prices far below commercial values cannot fail to affect the ability and the incentive to produce and to maintain or increase capacity. High prices are the prime incentive to expand production in the short run and capacity in the long run; they provide both the incentive and the wherewithal for the maintenance, improvement and extension of productive capacity in particular directions.

This is particularly obvious and important in territories where over large areas transport costs for bulky commodities are heavy, and where large sections of the population have not as yet emerged from subsistence production. In such countries the extension of capacity is necessarily to a large extent a function of price, since the establishment of new capacity and the production of crops for the market is not profitable or even feasible in outlying areas unless the price covers

* Landed costs refer to c.i.f. values plus duty. This basis of calculation slightly understates the rise in the true landed costs over this period, as it omits landing charges and storage costs which have risen greatly (more than in proportion to c.i.f. values) because of increases in unskilled wages and the congestion at ports.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

transport costs and still yields a worthwhile return more attractive than could be secured from other activity. Thus both long period supply and the general progress from a subsistence economy to a market economy are greatly influenced by the level of prices received by producers; and the payment of prices below market levels will therefore tend to have an adverse effect on production and on the growth of a money economy.*

10

Consideration of the arguments in support of these austere policies would be inadvisable here, as detailed examination would be lengthy and would introduce an unduly controversial note.† If desired this subject might form part of the discussion. But one obvious point need be taken up here. It can be plausibly argued that in the long run the producers cannot be affected by the retention of surpluses since what has been withheld will be returned to them. This argument, attractive at first sight, neglects important relevant factors.

First, if the funds were disbursed the producers who benefit would be a body of persons very different from those at whose expense the funds have been accumulated. Where the producers are anonymous (i.e., are not in direct contact with the marketing organization) the disbursement of funds by any marketing board is likely to benefit producers different from those from whom the funds have been collected; this applies even where the period between accumulation and disbursement is very short. In West Africa the accumulation of surpluses has been pursued for such a long period (when the operations of the West African Produce Control Board are also considered) that this inevitable corollary of statutory marketing has been greatly accentuated.‡ Second, the price policies so far pursued suggest that some of the boards (notably the Gold Coast Cocoa Board) are unlikely to permit large-scale drafts on their reserves for the maintenance of producer prices. Third, the maintenance of producer prices below commercial values over a number of years cannot fail to affect adversely the improvement and expansion of capacity and thus of output, which in turn reduces the surpluses available for distribution.

Further, the adverse results of the unsuccessful sales of the West African Produce Control Board and of the Groundnut, Oil Palm Produce, and Cotton Boards do not swell the reserve funds and are not returnable even in theory; and the same applies to the proceeds of the greatly increased export duties. Moreover, a substantial part of the funds has already been used for what is essentially general government expenditure, and it is probable that over a period of years the large accumulated funds will present an irresistible temptation to governments and politicians to be used for general and political purposes. This presumption is strengthened by the powers of direction over the funds of the Cocoa Marketing Board recently assumed by the Gold Coast Government.

Thus the argument cannot be sustained that the producers will be unaffected in the long run by the accumulation of surpluses.

11

It must not be inferred from the discussion that certain types of stabilization measure, clearly defined and specified, would not have solid advantages in West Africa or in other primary producing countries. In view of the critical discussion of the policies actually pursued it seems worth while to be explicit on this point.

The frequent and often violent fluctuations in prices and incomes in these territories entail important social, political and economic disadvantages. These frequent variations in prices may amount to a substantial daily revaluation of producers' services. Such fluctuations and revalua-

* This does not mean that the absolute level of output need be lower, but only that it will be lower than it would be if prices were higher. As is well known, the effects of a functional or causal relationship may be swamped by the operation of other factors, of which the general growth of the economy is likely to be particularly important in countries emerging from the stage of subsistence production. When trying to establish a functional relationship it is necessary for that purpose to disregard other variables.

† Some of the principal arguments have been examined by Professor F. W. Paish and myself in the *Economic Journal*, December 1952, and in *The Times*, March 12th 1951, and January 23rd 1953.

‡ This consideration is particularly relevant in the production of Gold Coast cocoa and of Nigerian groundnuts, in which there has been a notable change in the relative importance of different producing districts over the last fifteen years or so.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

tions are likely to have unsettling effects in all communities. The strains which are set up are likely to be particularly serious in communities on which the impact of a money economy is comparatively recent, and in which the population is apt to ascribe adverse price changes to the decisions and even to the malice of merchant firms. The same applies to the results of wide and often erratic fluctuations in prices and incomes between seasons. In West Africa (as in many other countries) the proceeds of exports are the most important component element of the flow of incomes, and wide discontinuous fluctuations affect the entire economy. Again, sharp short-term fluctuations in prices may set up expectations by producers resulting in reactions in the supply of products concerned which are not called for by long term trends. Moreover, discontinuous fluctuations retard the growth of a sense of continuity in economic affairs, which for various reasons (among which frequent fluctuations in incomes is only one) is often very imperfectly developed in primary producing countries. For instance in West Africa temporary high incomes may be spent quickly by the producers or other relatives or clansmen who wish to share in this prosperity and whom the producers have to support. A reduction in these fluctuations might promote a sense of continuity and thereby extend the economic horizon of the producers and increase their inclination to save; and in these and other respects may serve to promote development.

Thus the possibility of successful smoothing of fluctuations in prices and incomes deserves serious consideration. But worth-while treatment of this topic requires extended discussion, with a clear recognition of the conceptual and practical problems and difficulties of stabilization. General notions (such as references to stabilization without specifying the meaning of the concept) serve only to conceal baffling dilemmas and difficulties; and reliance on such vague ideas may result in the pursuit of very dangerous policies which may bring about a situation even less satisfactory than that which they are designed to remedy. But it would be inappropriate to pursue this subject further in a paper not concerned with recommendations for policy.*

APPENDIX

This appendix indicates briefly the sources and method of calculation underlying the tables in this paper where these are not stated in the text.

TABLES 1–6

The information on producer prices, f.o.b. prices, and export duties is based on the official figures as gazetted or notified in the circulars of the marketing organizations.

The prices paid by the Ministry of Food for West African and Indian produce have been made available for this enquiry from the records of the Colonial Office, those paid for Congo and Malayan produce have been made available by the sellers of these products. All these figures can also be very closely calculated from the trade returns, since the Ministry of Food bought on c. and f. or c.i.f. terms and was sole importer over the relevant periods.

The New York prices of cocoa have been made available by the United Africa Company, and are derived from Bache, a well-known book of reference of the cocoa industry. For the market prices of the other products since 1947 see the notes to Table 7 below. Where necessary, calendar years or fiscal years have been converted to crop years or vice versa. This presents no difficulty, since it is known what proportion of a season's crop is purchased by the end of the calendar year. Any small error is, of course, compensated for in the following year.

The producer prices of palm oil since 1949 are the weighted averages of different grades. For

* It has been suggested that the aims of policy examined in this section (or elsewhere in this paper) are irrelevant since the boards should be seen primarily as instruments for a large measure of socialization of saving in West Africa, and of closer governmental control over peasant producers, partly as an instrument for the socialization of saving and partly in order to direct agricultural production; and that their policies should be examined in the light of this criterion. This suggestion raises political and social issues of the widest significance. It would be inappropriate even to endeavour to discuss these here since not only have socialization of saving and socialization of peasant production not been advanced in support of the policies of the boards, but they are also tasks which are plainly outside the scope of organizations established to promote the interests of West African producers by means of price stabilization.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

earlier years in these tables they refer to grade 1 oil. The producer prices of cocoa refer to grade 1 throughout. This somewhat over-states the actual producer prices per ton, as it disregards the lower prices paid for other grades, and the discounts and penalties charged by the boards for these grades much exceed the commercial discounts. The producer prices refer to basic prices payable at ports or at railway line stations and for reasons explained in the text these necessarily exceed the prices actually received by producers; indeed, for most products lower producer prices are gazetted at road stations. Thus the rates of the various levies as percentages of producer prices are substantially understated in these calculations. In calculating the total of export duties on cocoa, allowance has been made for cocoa destroyed during the war, since on this cocoa no export duty was payable.

The procedure adopted in calculating the under-realization in cocoa is indicated in the text. For other commodities the following procedures were adopted.

For groundnuts from 1942 to 1948 the under-realization is the difference between the c. and f. price paid by the Ministry of Food for Indian and Nigerian groundnuts respectively. Thereafter it refers to the difference between the market values shown by the c.i.f. prices in Europe and the prices paid for Nigerian groundnuts by the Ministry of Food. As from 1948 there was a large market in vegetable oils and oilseeds in Western Europe, the c.i.f. prices are reliable indices of commercial values for bulk supplies.

In the calculation of the under-realization in palm kernels from 1942 to 1947 a more complex procedure had to be adopted because the Ministry of Food did not regularly purchase large quantities of palm kernels from sources other than West Africa, and it has thus not been possible to make a direct comparison between prices paid for the same product from different sources, such as was possible with prices of Indian and Nigerian groundnuts. An approximate estimate has been made on the following basis. Groundnuts and palm kernels are close but imperfect substitutes in oilseed crushing and their values are therefore related. The relationship is not constant, but tends to vary with the absolute level of prices. Over this period the Ministry of Food has bought the West African output both of groundnuts and of palm kernels on c. and f. terms. The discount of palm kernel prices below those of groundnuts was of the general order of one-quarter up to 1946 and about one-eighth from 1947. These discounts have been applied to the prices paid by the Ministry of Food for Indian groundnuts for these years to arrive at the estimated values of palm kernels to the Ministry. These values were set against the prices actually paid by this department for Nigerian palm kernels. This method is free from the objection that it used prices paid for marginal quantities for assessing the value of bulk supplies. From 1948 the contribution to buyers is based on the differences between the c.i.f. quotations for Malayan palm kernels in Europe and the prices secured for Nigerian palm kernels from the Ministry of Food.

For palm oil this item is based on a comparison between the c. and f. prices paid by the Ministry of Food for Congo oil and Nigerian soft trade oil, with a deduction of 10 per cent. from the price paid for Congo oil to allow for the higher quality of this product. This deduction is ample, in view of the fact that Congo oil was liable about this period to duty in this country while Nigerian oil is duty free, so that the effective cost of the former to the Ministry was 10 per cent. higher than the c. and f. prices on which the comparison in these tables is based. In the 1930's the Liverpool price for first quality Nigerian trade oil was practically identical with that of estate oil with only a few shillings difference per ton for differences in free fatty acid content. For these reasons the deduction of 10 per cent. from c. and f. value of Congo plantation oil before payment of import duty seems reasonable to arrive at an equivalent commercial value for Nigerian oil bought by the Ministry of Food.

TABLE 7

The information underlying this table requires more detailed discussion as it is derived from a variety of sources.

For West African products the prices shown in the table are producer prices, that is, prices paid at port of shipment or along railway line stations; for the comparable products from other sources they are c.i.f. prices less freight, i.e., broadly f.o.b. prices, after export duties and port charges. There are several appreciable cost items between producer prices and these f.o.b. prices

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of which transport, landing charges and export duties are the most important. These largely explain the pre-war differences in the absolute levels of prices between comparable commodities; thus Indian groundnut prices refer to f.o.b. price, the Nigerian prices to the Kano prices and the Gambia price to the Bathurst quotation. For palm oil the difference in the absolute levels between the Malayan and Nigerian prices before the war reflect differences in quality, as well as the influence of these factors.

The absolute level of pre-war prices shown here for comparable products are however very close where the West African producer prices are at port of shipment and where there are no significant quality differences. Thus the pre-war prices shown here for Gambia groundnuts (ex scale Bathurst) are very close to the prices for Indian groundnuts (c.i.f. Europe less freight); and similarly for Nigerian palm kernels (Lagos) and Malayan palm kernels (c.i.f. Liverpool less freight).

This method of presentation has had to be adopted because for Malayan and Indian products only the c.i.f. prices and freight rates were available in the form of a consistent series. The comparability of the figures for the purpose of the argument is not affected by these differences in absolute levels, as only the proportionate changes over this period are relevant.

The comparability of the figures would be slightly affected if the cost items between the producer prices and f.o.b. prices had changed in markedly different proportions in the different territories over these years. It is most unlikely that the differences in the relative movements of these items in India and Malaya compared with West Africa could have been so great as to affect the results significantly. In Malaya the only cost item of importance between the producer price and the f.o.b. price is the export duty. This was actually remitted in 1948–49 to assist the oil palm industry and the figures shown here understate the relative improvement of producer prices in Malaya compared to those in Nigeria. And it is most improbable that the comparison with India would be significantly affected if a series of producer prices were available instead of f.o.b. prices.

The Nigerian groundnut prices are the officially recorded Kano prices converted from a seasonal to a calendar year basis on the assumption that 60 per cent. of season's crop is marketed before the end of the calendar year.

For Nigerian palm kernels the pre-war prices are the Lagos prices recorded by the Produce Inspection Branch of the Department of Agriculture. For recent years they are the gazetted producer prices, less the small gazetted deductable allowance for middleman's commission. This is necessary to ensure comparability with the pre-war figures, and is the procedure adopted in the Produce Inspection records kept up to date in the Department of Marketing and Exports.

For Nigerian palm oil the pre-war prices are the Lagos prices for grade 2 oil as recorded by the Produce Inspection Branch. This is the most suitable consistently compiled pre-war series for this product, but its use presents a difficulty. In recent years the differentials paid by the Marketing Board for different grades of oil have been greatly widened and the proportionate discount of grade 2 oil below grade 1 is far wider than before the war. Moreover, in recent years the proportion of grade 1 oil has been much higher than before the war. Comparison in terms of the prices of grade 2 oil would understate the rise in the producer prices compared to pre-war; while a comparison of the producer prices shown in Table 2 (which is a weighted average of all grades) with the prices of grade 2 oil for 1935–37 would overstate the rise. To meet this difficulty two sets of prices are shown for recent years and compared with the pre-war price of grade 2 oil, one of the weighted average price for different grades and the other of grade 2 oil. When comparing the pre-war price of grade 2 oil with the average price of different grades in recent years (mostly grade 1 oil) it should be noted that the preparation of grade 1 oil requires more effort and work.

Although the Gambia is not covered in this paper, groundnut prices in that colony are shown here as they were accessible and are illuminating. Up to 1949 they are the official prices as reproduced in the *Annual Review for* 1949 *of Oilseeds, Oils, Oil Cakes and Other Commodities*, a well known reference book of oilseed markets issued by Messrs. Frank Fehr and Company. For 1950 and 1951 they are the official gazetted producer prices; in the Gambia the groundnut season practically coincides with the calendar year.

The prices of Indian groundnuts for 1935–37, 1948 and 1949 are from Messrs. Frank Fehr's

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

review; for 1950 and 1951 they have been kindly supplied by the buying department of Unilever Ltd. The freight deducted is the conference rate from India to North Continent ports. The pre-war prices of Malayan palm oil and palm kernels are the annual Liverpool prices, less freight from Singapore to Liverpool. For recent years they are the prices secured by the largest shippers of these products. For palm oil they are f.o.b.; for palm kernels they have been converted to f.o.b. by deducting freight at conference rates from Singapore to Europe. For palm kernels the 1948 prices refer to the second half of the year as shipping to Europe was not available for the first half of the year.

TABLE 8

The producer prices underlying this table are those indicated in previous paragraphs of this appendix. For the reasons already explained for palm oil for this series the grade 2 price had to be taken.

Landed costs of cotton piece goods are the c.i.f. values plus duty.

DISCUSSION ON MR. BAUER'S PAPER

Dr. E. HALLETT: Some among us may feel that the author has embarked on a theme which is unusually controversial for a paper read to this Society; some may even regard it as having political implications. In proposing a vote of thanks to Mr. Bauer, therefore, I think the first thing to do is to try to keep the argument out of the field of political controversy. There is quite enough controversial matter in the statistical and economic fields.

The concept of "under-realization" of West African produce must leave in most of our minds the feeling that those responsible for the marketing of West African produce since 1939 are being charged with negligence or incompetence. I am quite sure that Mr. Bauer has no such thought in mind; he would be the last to use an address to this Society as a vehicle for such views. If I interpret him rightly, he is merely saying that in different circumstances it ought to have been possible to obtain a better price in certain years for some of West Africa's products ; and he tries to find a measure of the difference between actual and potential prices.

I believe he has had access to much information not easily available to the general public. But he could not have known what was in the minds of the various responsible officials at the time the relevant decisions were taken. It is not perhaps given to all of us to experience the difficulty, indeed the virtual impossibility, of trying to relate the statistics of a series of marketing operations to the actual decisions upon which they were based. It is impossible for an impartial investigator to recapture the thoughts which led the marketing authorities to make certain decisions. In the absence of complete knowledge of the circumstances in which selling arrangements were made there may well be some who regard the statistics which Mr. Bauer has given under the heading "under-realization" as being incapable of proof. Others will be content with the rather cynical argument that from the marketing aspect any "under-realization"—if it exists and can be determined statistically—is a measure of the weakness of West African bargaining power in the war and the immediate post-war years.

Again, others may question the author's figures for "under-realization" on purely economic grounds. The author has pointed out that the higher prices paid for produce offered in other parts of the world were paid for bulk supplies and not for marginal quantities. This, however, can be a boomerang argument. If this subject has any importance at all, it is partly because West African supplies themselves are far from being marginal ; in fact, in the case of cocoa they form the bulk of the world's supplies. The author does not appear to have made much use of the concept of elasticity of demand. Without knowing something about this, it is difficult to see how anyone can calculate what price would have been paid for West African produce had it been thrown on to a free world market. It cannot be said that the author's figures are wrong, but there is no proof that they are right. Everyone who has actually dealt in a commodity market knows the effect on the whole market of the knowledge that a certain proportion of the supply is controlled by one authority.

I come now to the statistics of the levies on West African producers. Many of us may disagree with the use of the word "levies", but it is very difficult to find a suitable expression. If, following what I have just said, the columns headed "under-realization" in the Tables are regarded as purely conjectural, we are left with the export duty and the surpluses of the Marketing Boards as the "levies" on the producers. We shall maintain a better sense of proportion if we regard these

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

"levies" merely as a form of manipulation of the prices by local governments or marketing authorities, with certain purely local ends in view. The fact that these local price manipulations have resulted in the accumulation of sterling balances need not concern us now. It is not our business to question the decisions which brought this situation about. But we may be permitted, as statisticians and economists, to consider what might have happened on the production side had higher prices been made available to the producer himself. The author has argued both here and elsewhere that this must affect the improvement and expansion of capacity and output. No one can actually prove what would have happened if something had been done other than what was actually done. That is where scientific experiment has the better of history and economics. The best we can do in this case is to look around for a product which bears some comparison with the products handled by the marketing authorities in West Africa, that is produce from field or forest which has been either grown or culled by African peasants. It so happens that in the production of rubber in Nigeria, most of which is in African hands, we have an admirable example of response to a price stimulus. Sixteen years ago the actual exports of rubber from Nigeria were about 5 million lb. and the f.o.b. price averaged about 5*d.* a lb. In 1951, which was the peak price year, when the f.o.b. price was over 3*s.* a lb. or nearly 8 times the pre-war price, the exports amounted to 47 million lbs., or about nine times the pre-war exports. A similar reaction to price incentives is to be found in alluvial diamond mining by Africans in the Gold Coast.

Thus far I am entirely with the author. But I would not go so far as to say—and I do not think the author would either—that similar unbridled price incentives in the field of West African export produce would have yielded comparable increases in supply. There are certain limits—weather, pests, rotation of crops—to potential agricultural production, and in the case of tree crops there is also the time interval between the planting and maturing of the trees. Some of us may think that the payment of the equivalent world price for cocoa would have caused an unparalleled rush to plant new trees. Others will think that any further price incentive beyond a 15-fold rise in price (which is actually what happened between 1942 and 1952) would have had little effect. In the case of palm oil, which is produced largely from wild trees, the post-war price policy of the Marketing Board has not only increased production but has also improved quality. I do not know how one could statistically translate improvements in quality into terms of increases of supply; but the recent rise in quality and quantity does constitute evidence—and the evidence is not lacking in many other fields in West Africa—of the African's response to price incentives. Statistically, then, we can find acceptable proof of the general principle, but we cannot prove what might have happened if circumstances had been other than they were.

Perhaps I should direct your attention to one other point. In the Table showing the index of the terms of trade the author has taken the prosperous years, 1935–37, as the base period for his calculations. The danger of selecting any base period is that it may be regarded as a criterion of the normal. Historically speaking, what is normal cannot be defined. Had the depressed years, 1938–39, been taken as a base a rather different picture would have emerged. This is no criticism of the author's remarks but merely a caution to the unwary.

I am sure we are all most grateful to Mr. Bauer for introducing us to this most interesting subject. The thoroughness of his investigations, his grasp of detail, and the tenacity with which he maintains his theme are well-known to many of us and need no emphasis of mine.

Miss P. DEANE: It is a great pleasure to second the vote of thanks to the author of such a competent and worthwhile piece of research which happens to be within my own sphere of interest. I should like to begin by expressing my own personal satisfaction at the author's lucid exposition of this important subject. It is not necessary to emphasize the importance of the marketing boards—the author has already done that for us. The boards were initiated in an experimental way and were developed in conditions under which the broader issues of economic policy were subordinated in some sense to the narrower issues of war. In these circumstances they developed, in the author's own words, "without a clearly defined mandate". It is disputable whether it is desirable or profitable to give an unambiguous and clearly defined policy directive to new institutions of this kind. But it is undoubtedly true that it is desirable to subject their activities to a constant and watchful review and to take nothing for granted either in their constitutions or their policies.

The author's brilliant analysis of the price policies of the marketing boards from 1939 to 1951 is I think, a valuable contribution to the records of those whose business or interest it is to make this kind of review. It is also a powerful indictment of the policy of the marketing boards, but as we are avoiding controversial topics to-night I do not suppose that any counsel for the defence will come forward. At the same time, I hope that those present who know much more about West African conditions than I do will be able to comment specifically on some relevant factors of the economic situation which the author's searchlight has perhaps failed to illuminate. Those who

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

like myself have only a superficial and secondhand knowledge of West African conditions may be tempted to guess at their content and significance.

It is not inappropriate to begin, however, by reminding ourselves of the spirit in which these marketing boards were set up. The Annual Report of the Secretary of State for the Colonies which dealt with the period 1939–47* and was published soon after the boards were formally set up, began the section on marketing arrangements by stating that: "It is a well-established fact that primary producers suffer most from the periodical booms and slumps of modern economic activity. The crucial importance of improving marketing arrangements for colonial primary exports is thus apparent. In no other single way can such an immediate and direct contribution be made towards increasing the real wealth of colonial peoples". Evidently the spectre of the next slump was very much in the minds of those responsible for colonial policy. The report went on to say that: "The essential purposes of this form of collective marketing organization are, first, to improve the physical organization of marketing and transport costs; secondly, to improve the bargaining power of producers who have in the past been handicapped by facing, as individuals, highly concentrated organizations of buyers, and, thirdly, to even out world marketing fluctuations by price stabilization arrangements. For the latter purpose it is essential that the direct link between the price received by producers and the world market price should be broken in such a way that, although the producer receives over a period of years the same average price as he would have received by following every upward and downward variation in world prices, his actual price will vary much less from the average during periods of very high or very low world prices".

If we consider the rôle of the marketing boards in the light of these objectives, we may note that on the first two of them the author does not attempt to provide the data to assess the effectiveness of the boards in improving the physical organization of marketing, reducing transport costs, and improving the bargaining power of the producers. The argument that the marketing boards have failed to realize prices for their products which were as high as those realized by other sellers of similar products at the same time is, in general, to say that they have failed to drive as hard a bargain with the Ministry of Food as they would presumably have done if they had been independent merchants. Whether the producers as opposed to the merchants would have obtained a better market price under free marketing arrangements is a different matter.

Some idea of the contribution of the boards to the achievement of price stabilization can be obtained from Table 2 of the paper, where it will be seen that in the years 1949–50, for both Gold Coast and Nigerian cocoa, there was a drop in producer prices which we might perhaps trace to the drop in the surplus in the previous year. We may deduce, as the author has deduced, that some of the boards are keeping a very careful eye on reserves. We might also deduce that other factors, apart from supply and demand of the particular commodities in question, might have influenced the boards in setting their price position. Unless they have unusual views about the probable severity of the next slump it would seem on the face of it that their reserves are larger and more jealously guarded than they need be. Indeed, the transactions of the West African marketing boards are on such a vast scale relatively to the economies in which they operate that it is inconceivable that they would base their decisions on producers' prices purely in terms of their effect on producers. Where they export a food crop it is proper that they should pay some attention to the effects of an increased export price on the price of supplies available for home consumption. Where they export a crop which contributes a large proportion of the cash income of a particular territory it would presumably be proper for them to consider the possible inflationary effect of such a sudden rise in income. In this connection it should be noted that for much of the period covered by the author's analysis the volume of imports was restricted artificially either by wartime shortages or post-war shortages or by exchange control restrictions. Whether or not it is desirable that a metropolitan power should exert a larger influence over sterling area resources in dependent territories than it can negotiate for those of independent territories is another matter. But these limitations on imports were part of the situation which had to be considered by those making the price decisions.

It is of interest to consider some of the author's observations on the terms of trade in this connection. In Table 8 indices are given of the terms of trade of West African producers based on the landed values of imported cotton piece goods and of the "producer prices" for the principal export crops. The author has pointed out, however, that the difference between final retail prices for these goods and growers' prices for export crops is very much wider. It would be interesting to know whether the *growers'* terms of trade showed such a marked deterioration compared with the 1935–37 level as Mr. Bauer's calculations suggest. If one may judge from the report of the 1938 Commission on the Marketing of West African Cocoa,† it was the growers who

* *The Colonial Empire* (1939–47), Cmd. 7167, H.M.S.O., 1947. Paragraphs 360–367.

† *Report of the Commission on the Marketing of West African Cocoa*, Cmd. 5845, 1938.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

were squeezed by the intense competition amongst the merchants, and the middlemen who won. Producers' prices which include middlemen's margins may overstate the growers' advantages in the 1935–37 period and understate them in the period of control. Further it is arguable that if an inflationary situation had been allowed to develop in a period when there were severe import restrictions on consumer goods, the *growers'* terms of trade, measured in prices operative at the village level, might have worsened a great deal more than Mr. Bauer suggests they did.

I should like to stress that I consider this to be a very valuable piece of research, and I hope that the author's work on the subject will stimulate a very thorough review of the policies and activities of these important marketing boards.

Miss P. ADY said that Mr. Bauer's contributions to this hitherto neglected field were always most stimulating. His paper raised a number of controversial issues, but she would confine her comments to queries concerning the construction and significance of the statistical data he presented. Her first question concerned Mr. Bauer's estimate of under-realization. This estimate depended on a comparison of the unit-value of proceeds in sales upon the world market by the West African Marketing Boards with prices paid to shippers of similar products from other parts of the world. It did not seem to her that the series Mr. Bauer presented were in fact comparable. Whereas the Marketing Boards' sales proceeds were unambiguous in meaning, the prices series relating to India and Malaya were not. Had Mr. Bauer examined the reasons for the price differences he would have found many causes other than "under-realization". To examine, for example, the prices relating to India groundnuts (Tables 1 and 7): in this series the major factor in the tremendous spread of the differential in latter years was the Indian Government's prohibition of groundnut exports in 1946. This prohibition lasted for 12 months and was followed by licensing, the licences being issued only after many delays and the total licensed quantity being much below previous exports. This and not the re-opening of European markets accounted for a rise in export prices, which was intensified by the shippers' natural reaction to the new situation. This reaction was to concentrate purchases upon the highest quality and hence the most highly priced nuts. Similarly, in earlier years, adjustments were necessary to allow for differences, which increased during the war, in transport costs between the United Kingdom and these two parts of the world, and more specifically the special character of Ministry of Food contracts with shippers from India which made the stated f.o.b. prices higher than those paid in India. The non-comparability of West-African with Malayan prices was again due to the small size of shipments in these early post-war years.

Miss Ady than turned to Mr. Bauer's estimates of changes in the producers' terms of trade. Her first query here concerned the structure of the West African price series presented in Table 7. This purported to show the course of money prices received by the West African producer before and since 1939. She did not think that this presented a valid series, as the prices used for the base period 1935–37 were not comparable with those paid since the inception of marketing boards. The Marketing Boards' prices were net of brokerage and other costs of collection of the produce from the farmer (including in most cases costs of transport) and they represented very closely what the farmer received. This was not so with the prices used by Mr. Bauer for the period 1935–37. For palm produce he used Lagos prices and it was clear that his so-called producer price included the costs of bringing palm produce to Lagos, the main port, and also the broker's margin. In the same way his Kano prices for groundnuts for the base period included all costs of collection except the rail freight from Kano to Lagos. In short the pre-war prices Mr. Bauer had used as his basis for comparison were not producer prices but those at which brokers sold to shippers. We knew that in the pre-war market the spread between these two prices was considerable. For, with daily fluctuations in world prices and the paucity of communications, the broker was in a key position to speculate heavily both against the farmers from whom he bought and the firms to which he sold.

Thus, even if Mr. Bauer has obtained a weighted average of prices for all transactions in the appropriate crops in Lagos and Kano in the years 1935–37 (and it was puzzling to see how he could have done this for pre-war years from the inadequate records of his source, the Nigerian Produce Inspection Department, or indeed for Gold Coast cocoa where there was no official produce inspection in pre-war years) this average would inevitably be far higher than the price actually received by the farmers.

It was not surprising that in the year 1939 when the f.o.b. price of cocoa was 9*s.* a load, contemporary reports spoke of 6*s.* as the rough average of the season's level. Yet even this was only the spot price, and a further adjustment was needed to cover the farmer's losses through forward sales. The farmer often found it necessary to borrow money before the work of harvesting his

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

crop began and the loan was customarily secured against an advance sale of his produce. The farmer contracted to deliver later a fixed weight of his crop in discharge of his obligation when the harvest was gathered. The high proportion of the crop tied in this way, and the low price customarily agreed, meant that the average price actually received by the farmer before the war was still lower than that obtaining in spot sales.

Mr. Bauer's comparison of statutory producer prices with pre-war brokers' prices (if they might be so termed) inevitably made the levels paid by the Boards since 1939 seem very low. Also, the base years he had selected imparted a heavy downward bias to the series, as Dr. Hallett had already pointed out. Miss Ady knew of no way of getting a representative average of pre-war producers' prices for any of these crops, but some indication of the year to year changes could be obtained from the f.o.b. figures. Gold Coast prices f.o.b., for example, ranged between £16 a ton and £22 a ton from 1930 to 1939 with the exception of the years 1936 and 1937, when they were £24 and £41 respectively. The average f.o.b. price of cocoa for Mr. Bauer's chosen base period 1935–37 was therefore £27 a ton compared with £21 for the whole period 1930–39. For the years 1938 and 1939 the average f.o.b. price was only £16½. In basing his series on the short-lived boom of the middle thirties Mr. Bauer implied that the primary producer compared his lot throughout the war with the sudden flush of prosperity he had enjoyed in this short period and forgot the long years of low prices which had preceded and followed it. This was contrary to the impressions she had formed in the course of discussions with farmers in the cocoa belt of the Gold Coast and Nigeria during the years 1945 and 1946.

Miss Ady then turned to the terms of trade index which Mr. Bauer derived from these figures. Table 8 was derived from Table 7 by deflating by an index of the landed cost of cotton piece goods. Mr. Bauer took the view that this procedure did not overstate the fall in the producers' terms of trade but she was less certain for two reasons. She had herself published* an index of consumer import prices for the Gold Coast and Nigeria for the years 1921–1948. The textiles component for the Gold Coast in 1947 (1938 = 100) stood at 353 when the index of all other consumer goods imports was only 175. The same order of difference characterized the Nigerian series.

Mr. Bauer defended his procedure on the grounds that "retail prices rose proportionately much more than landed costs". It seemed from this that ideally he would wish to deflate producer prices by a retail price index. But this seemed to introduce a conceptual confusion. For the inflated size of retail margins was due to quite another factor—the scarcity of imports. Had producer prices been higher in this period before 1948 retail margins would have risen proportionately and the producers terms of trade would have remained unchanged.

If an index of retail prices were used to measure changes in the terms of trade in Mr. Bauer's sense it seemed that we could get only one answer in such an inflationary situation in West Africa —that given by the volume of imports, *not* that given by their cost. The use of such an index seemed to mix together two separate influences—those due to the terms of trade proper and those due to inflation.

Mr. Bauer had apparently not realized this possible source of confusion, for he also used his terms of trade index as a measure of changes in retail prices, and hence changes in living standards. This could be seen in a footnote to Table 8. He concluded from these changes in the terms of trade that "the reduction in the level of real consumption of these producers may have exceeded that of most belligerents".

Even if measured by a more general index of the prices of imported consumer goods, surely the terms of trade were not a measure of real consumption in any country? Imported items were only a part of the consumers' budget even in West Africa. There was also a considerable consumption of housing, foodstuffs and other goods and services a large proportion of which were not only locally produced but even self-produced. Mr. Bauer's terms of trade index related only to a fraction of total consumption, if indeed we could be certain that textile purchases were always for consumption in a country where fine cloths had until now been one form in which to hold savings. Mr. Bauer's footnote already quoted indicated the extent to which this sort of table could mislead.

This was not to deny that the terms of trade of primary producers deteriorated during the war but she did not think the fall was as drastic as Mr. Bauer suggested, or that it carried the welfare implications he imputed to it.

Mr. Bauer presented two other sets of figures, the Boards' accumulated surpluses and the aggregate export duties paid by them to their respective governments. These figures were unambiguous in derivation but the significance which Mr. Bauer imputed to them raised issues of principle too numerous to pursue here. She would only say that she did not consider it proper

* *Bulletin of the Institute of Statistics*, December, 1949.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to describe the Boards' surpluses as levies in the same sense as the export duties. Nor indeed did she feel justified, on the evidence we had, in describing them as levies at all. This depended upon one's view of the Boards' intentions with regard to price stabilization in the event of a major slump and she was less cynical about this than was the author of this very interesting paper.

Dr. J. R. RAEBURN said it was most important to assess the value of the reserves built up in the past against reasonable estimates of the probabilities of various price declines in the future. Mr. Bauer had made interesting assessments two years ago for cocoa, but how did the £160 million of reserves in Table 3 appear now in relation to probable world price movements and the prices being paid to producers. For cocoa, price fluctuations in the world market could certainly be sudden and large. But also, by how much had the contributions to the total reserves declined in real value since they were levied?

The figures in Table 4 and 8 for cocoa prices to producers in the Gold Coast as compared with those in Nigeria showed an apparent discrepancy, which was difficult to explain.

He did not wish to embark on policy problems but these could not be entirely avoided. It seemed proper to admit that, during wartime, control of the allocation of exportable supplies among the Allied Nations and neutrals, and of the movements and loading of ships, may have affected decisions on the establishment of the West African control boards, as well as of bulk purchase arrangements for many other types of produce. Also it was important in considering Table 1 to distinguish between "under-realization" and the fixing of really appropriate prices to producers. The c.i.f. prices for Nigerian groundnuts clearly were kept low, relatively to those for Indian groundnuts, but more groundnuts were piled up in Northern Nigerian market towns than could be moved by rail to the seaboard.

He congratulated Mr. Bauer on his scholarly efforts to clarify the concept of "stability". These had made a real contribution. In addition, however, it was essential to be clear about the full meaning of productive "capacity", its maintenance or increase. He did not wish to over-stress the conservation aspects of the economic and agricultural problems of West Africa, but probable changes over comparatively long time-spans had to be brought into the account. Human populations were increasing and demands for consumption goods were rising but we did not yet know how to maintain cheaply soil fertility and freedom from serious plant diseases. Quite apart from social obstacles, the technical position was quite different from that in Western Europe or the more thickly settled areas of North America. And the scientific resources devoted to the basic technical problems were far smaller.

Dr. A. R. PREST wished to comment on the author's treatment of export duties. There were two different ways of treating the operations of the marketing boards, the choice depending on whether one regarded them as an independent authority or as a government agency. If the first, then surely it was not legitimate to introduce export duties into the argument at all; if the second, then the benefits producers received from the expenditure of the duties should be set off against the duties. The author's treatment seemed to him to be an unsatisfactory half-way house, for it could not really be argued that, as in the case of under-realization, the increases in duties were a direct result of the Board's activities. The major rises took place in 1950 and 1951 at the same time as higher export duties were being imposed all over the world and indeed on non-marketing board exports from Nigeria. Table 4 clearly showed that these increases in export duty did not result in cutting the Board's margins but, on the contrary, were accompanied by a rise both in those margins and in producer prices.

Professor MILTON FRIEDMAN emphasized the contrast between the effects revealed by Mr. Bauer's figures and the objections raised either to their statistical accuracy or to interpreting them as a criticism of the marketing boards. The striking fact brought out by Mr. Bauer's extraordinarily interesting figures was that the operation of the marketing boards has involved the equivalent of a tax of well over 50 per cent. of the net incomes of a class of primary producers, many of whom have very low incomes. Despite his ignorance of the detailed statistical evidence, it seemed hardly credible from the internal evidence of the paper that this figure could be in error by enough to invalidate the general conclusions that it suggests; all the statistical criticisms raised seem of a much lower order of magnitude.

The imposition of a charge on the producers is justified as an insurance payment for increased stability of income. Again, whether or not generally valid this point too seems of the wrong order of magnitude: a charge of over 50 per cent. of income seems an undue charge for insurance,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

even if the programme could be shown to have produced greater stability, which seems by no means clear. It hardly seems credible that the primary producers would voluntarily buy insurance at this price.

Mr. Bauer's figures impress one as another piece of impressive testimony to the discrepancy between the will and the deed. The actual results surely do not conform to the intentions of the initial proponents of the marketing boards or even of their managers. Had the actual behaviour of prices and output been foreseen, it is hard to believe that a much larger share of receipts would not have gone to the producers. The fear of a post-war slump had its devastating effect here as in so much of post-war economic policy.

These particular plans suffered from the chief defect that had characterized so much of modern writing and thinking about stabilization policy in general, namely, the naive belief that good intentions are enough. If the government recognized its responsibility for maintaining full employment and stable prices all would be well. Marketing boards operating in the (undefined) best interests of (undefined) groups, were bound to do good. But unless the intentions were matched with an ability to forecast both the action required and the effects of actions taken, the result of trying to do more might well be to make matters worse rather than better, as it so clearly was in the case examined by Mr. Bauer.

The ultimate responsibility of modern states for their monetary systems makes some general stabilization policy inevitable. There was no such justification for marketing boards or any substitute means of stabilizing the receipts of producers of particular crops. The appropriate solution was rather to let the market reign, with the government restricting its activities to seeing that the market was kept free and that price-fixing and other monopolistic practices were prevented, and to providing as stable a general monetary framework as it could.

Mr. BAUER subsequently replied in writing as follows:

Dr. Hallett suggests that in the absence of complete knowledge of the relevant circumstances, and in particular without knowledge of the intentions of the authorities, the statistics which I gave under the heading of under-realization might be thought to be incapable of proof. In my view, the intentions of the authorities are not relevant. I simply reviewed the results of the policies. Thus Table 1, for instance, is not based on guesses of intentions, but is derived simply from the official trade returns. Dr. Hallett further argues that without knowing something about the elasticity of demand it is impossible to say what would have been paid for West African supplies if they had been thrown on to a free world market. The elasticity of demand would be relevant only if West African supplies had been restricted by the marketing authorities; in that case it would be legitimate to enquire by how much the price would have fallen if additional supplies had been thrown on to the market. But the authorities sold the total supplies at their disposal; and as shown in the figures presented in my paper, they realized lower prices than were paid to other bulk suppliers of these products. This proposition would need qualification if, as a result of low producer prices, supplies had contracted sufficiently to affect market prices significantly. It is certain that this did not apply over this period, nor is it suggested by Dr. Hallett that it did. West African exports of oilseeds and cotton are such a small proportion of total world exports of these commodity groups that market prices would not be affected even by comparatively large changes in the volume of exports from West Africa. This does not apply to cocoa, of which exports from West Africa are about one half of world exports. But although the long period elasticity of supply of cocoa is most probably considerable the short period elasticity is comparatively low. It is certain that market prices (which were, moreover, controlled over much of this period) were not affected significantly by the repercussions of the producer price policies of the Cocoa Boards.

The method of calculation of under-realization is stated explicitly in Section 5 of the paper, and, so far from being conjectural, as Dr. Hallett suggests, the figures are derived from comparisons of prices received by the marketing authorities on the one hand and by other bulk suppliers of the same or closely similar commodities on the other. They refer mostly to prices paid by the Ministry of Food for supplies purchased on otherwise identical or very similar terms.

Dr. Hallett also argues that it cannot be established that the payment of prices below market values has adversely affected the maintenance and extension of capacity (and therefore long period supply) because there are so many other factors at work influencing output. This view, in my opinion is fallacious, since there can surely be no reasonable doubt that the maintenance and establishment of capacity is to a considerable extent a function of price. When establishing a functional relationship between two variables it is necessary for that purpose to disregard the operation of other forces.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Dr. Hallett's reference to the fifteen-fold rise in the price of cocoa is somewhat inappropriate as a picture of the operations of the boards throughout this period, as will be readily seen by a glance at the statistics presented in my paper, which cover the complete period.

Most of the improvement in quality referred to by Dr. Hallett is of little economic significance since it does not correspond to quality differentials recognized by the market. Dr. Hallett moreover fails to make the important distinction between economic and technical efficiency.

Miss Deane refers repeatedly to the improvement in the bargaining power of producers brought about by the operations of the marketing boards. In view of the information presented in Table 1 of the paper this is not a felicitous point to make. Actually there is a good deal of misunderstanding on the whole question of the bargaining power of producers. An individual's bargaining power depends largely on access to alternatives, and it is the presence and absence of these, and not such matters as ignorance, illiteracy, price fluctuations, and so forth, which are likely to determine whether a seller will realize the market value for his product. I may perhaps be allowed to refer to an article by Mr. B. S. Yamey and myself in *Economica*, February 1952, where this matter is examined at some length, with special reference to buying competition in the groundnut trade.

Miss Deane refers to the Nowell Report which, according to her, showed that "it was the growers who were squeezed by the intense competition amongst the merchants, and the middlemen who won". This contention is not easy to accept. I should have thought the African community could only benefit from intense competition among the export merchants. It is a well-known feature of the Nowell Report, which Miss Deane seems very readily to accept, that it argues that both the buying firms and the producers were exploited by the middlemen. This, however, is improbable in view of the fierce competition among the middlemen, and the ease of entry into small scale produce buying. The middlemen could benefit from sharp practices only by securing tonnage; and in these circumstances any substantial abnormal gain would be competed away in favour of the parties the middlemen served, i.e., the producers and the buying firms. They could have retained these gains only if they could have successfully barred entry into their ranks, but there is no reference to this in the Nowell Report.

Miss Deane also mentions the danger of inflation as an argument in support of the price policies of the boards. As I have written elsewhere, the suggestion that, in order to prevent inflation, incomes have had to be severely restricted below the sales proceeds of exports implies that the British authorities have pursued a deliberately exploiting policy in accepting the essential products supplied by West Africa (or their foreign-exchange equivalent), while refusing to make available even an approximately equivalent volume of imports to the much poorer populations of West Africa.

It can be shown that from 1948 at any rate, sufficient imports were available to absorb higher incomes without substantial increases in prices. This can be seen from various pieces of evidence, such as the response of the volume of imports to the level of producer prices over this period; or from the share of West Africa in all British colonial imports, which was appreciably less than its share of British colonial exports and shows that supplies were diverted elsewhere by the superior pull of unrestricted incomes; or from the absence in other sterling area territories of the measures and policies pursued in West Africa; and from the accumulation of stocks of merchandise (especially of textiles) in West Africa in 1949–50, accompanied by reductions and cancellations of their commitment by merchants.

The control of inflation, a task somewhat more complex than might perhaps be inferred from Miss Deane's remarks, is surely the function of the monetary authorities and not of the marketing boards. Further, Miss Deane implies, as do many others writing on this subject, that the burden of deflation should be borne by the producers of export crops, and that organizations established to promote their interests should be used to restrict consumption by withholding a large proportion of the incomes of one section of the community only, namely their own constituents, contrary to specific assurances at the time of their establishment.

Miss Ady suggests that the spread between the c.i.f. values of Indian and Nigerian groundnuts in the United Kingdom resulted largely from the prohibition of groundnut exports from India in 1946. As is clear from Table 1 of the paper (which is derived from the trade returns of the United Kingdom), the spread developed in 1942, immediately on Nigerian exports being taken over by the West African Produce Control Board. As this organization sold to the Ministry at cost prices based on the very low producer prices, while Indian exporters sold on much better terms, there is no need to look for other explanations. The widening of the gap between these prices in 1947 and 1948 had little to do with the temporary prohibition of exports from India. It was a result of the world-wide rise in the prices of vegetable oils and oilseeds, following the decontrol of prices in America and the revival of European markets. For familiar reasons the prices of the principal vegetable oils and oilseeds are very closely related, and the prices of Indian groundnuts

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

moved in sympathy with other oilseeds. The prices paid for West African produce by the Ministry of Food lagged greatly behind this rise in prices, which explains the further widening of the substantial gap between these prices. In fact throughout this period appreciable quantities of groundnuts were exported from India.

Miss Ady also implies that before the war the intermediaries secured large gains at the expense both of the exporters and of the producers. For reasons stated above this seems incorrect. Further, it is not at all certain that the position of the producer *vis-a-vis* the middleman-moneylender has been stronger over the period of statutory marketing than it was before its introduction. The compression of producers' incomes at a time of steadily rising prices of merchandise, and the centralization of saving, would suggest the reverse. But in any case, in any discussion of the effects of the pledging of crops, or of forward sales to moneylending intermediaries, it is necessary to separate the selling and moneylending elements in these transactions, since presumably if the producer has to borrow, and cannot borrow from a produce buyer, he will have to go elsewhere and pay heavier interest charges.

The series of producer prices used in the calculation of the terms of trade referred to comparable data. For instance, the series underlying the indices of the producer prices of groundnuts, of palm oil, and of palm kernels, are still used as comparable data by the Government departments in Nigeria, from whom I obtained them. But even if these prices exaggerated producer prices more than the gazetted prices used since the inception of statutory marketing (which I do not believe), the difference is, of course, negligible compared to the levies on producers since the establishment of statutory marketing. It is these levies, and not my calculations, which make producer prices since 1939 seem low.

Much of Miss Ady's discussion deals with my calculations of the terms of trade of the producers. This was a side issue, which does not merit extended discussion. However, the answer to Miss Ady's arguments is that there can be no reasonable doubt that the operation of statutory marketing greatly depressed the terms of trade of producers compared to what they would have been in the absence of such a system. This is obvious from the fact that producers have had to pay open market prices for the merchandise they buy, while they have had to sell their crops at prices far below commercial values. This conclusion is quite independent of the choice of the base period and of the composition of the index.

It is common ground that textile import prices increased more than those of other consumer goods in West Africa. But I am surprised by Miss Ady's suggestion that on the base of 1938 = 100, the textile component for 1948 was 353 while that of all other consumer goods was 175. The figure for the rise in textile import prices is very similar to mine, but that for other imported consumer goods is not easy to accept, at any rate for a calculation of producer terms of trade. It seems worth mentioning that the Colonial Office index of Nigerian import prices (1939 = 100) stood at 329 for 1949, and this almost certainly understates the true rise in import prices.

My choice of the base years 1935–37 for the calculation of the terms of trade does not present an unduly favourable picture. If I had chosen an earlier period up to 1933, the base period would have been even more favourable to the producers. Only the years 1934–35 and 1938–39 would have resulted in a significantly less favourable base period. The use of producer prices in these calculations moreover means that the very low up-country prices of groundnuts in the autumn of 1937 are fully included in the calculations of the base period, while they were not fully reflected in f.o.b. values until somewhat later.

The effects of statutory marketing on the terms of trade of producers through the withholding from them of a large part of sale proceeds are unambiguous. Disputes over the choice of the base period, and similar matters, can only obscure the essential points.

I cannot agree with Miss Ady that the introduction of retail prices into a calculation of producer terms of trade (which in fact I did not do) would be a conceptual confusion. In calculating the terms of trade of producers the ideal course would be to set up-country retail prices against producer prices. The policy implications may well be different if a rise in retail prices is the result primarily of the widening of the margin between retail prices and import prices, rather than primarily of higher import prices. But this is only an example of the limitation of the uses of quantitative data as a guide to policy; it does not affect the computation of changes in the terms of trade. Miss Ady's statement that if producer prices had been higher retail prices would have risen proportionately would be true only if the supply of imports had been perfectly inelastic, which it certainly was not at any rate from 1948. And even if retail prices had risen proportionately it would not follow that producers would not have benefited from the higher price; this would be true only if they spent their entire incomes on imports, which of course is not the case.

I am sorry if my wording suggested to Miss Ady that I used the terms of trade as a measure of changes in retail prices or in living standards. It is, of course, obvious that expenditure on

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

imports is only a component element in the standard of living of the producer. Strict reading of my footnote to Table 8 does not support the interpretation which Miss Ady has placed on it, but I agree that it is not happily expressed.

Dr. Raeburn reminds us that the accumulated reserves are available for prospective disbursement to producers; but he also suggests that the seemingly very large reserve would not last very long if there were a large fall in world prices, and it were desired to maintain fully the level of producer prices. On the first of these points I do not want to add anything to what is said in Section 10 of the paper, where this argument is explicitly considered. The other point bears on an important conceptual and practical problem which arises if stabilization is not defined clearly, and if the period over which it is to operate is not specified.

The higher prices are, the larger are the absolute amounts required to maintain them at a given level over a stated period, and therefore a given sum is more likely to appear insufficient as stabilization reserve. Surpluses accumulated over a number of years of relatively low prices, and representing large percentages of producer prices at the time of their accumulation, may be held to constitute an insufficient reserve at a subsequent date (by which prices have risen greatly), even though the fear of a decline had been adduced as a reason for their accumulation. When prices are rising over a number of years it is therefore quite likely (in the absence of a clear definition of stabilization, or of the period of accumulation) that the producers who receive the low prices of the early part of the period are called upon to surrender a proportionately large part of their incomes for the creation of reserves which may either be accumulated indefinitely, or used to subsidise much higher producer prices in the face of a possible decline. This decline may represent a much smaller proportion of the higher prices than the proportion which the producers have to surrender at a time of much lower prices. And of course the beneficiaries of this process are a group of persons quite different from those who have had to make the sacrifice. This is the reason for the apparent insufficiency of the large surpluses, which over the years have represented such a considerable proportion of sales proceeds.

The explanation is simple for the divergent movement in the terms of trade of Gold Coast and Nigerian cocoa producers in 1950 and 1951. The series in Table 4 refer to crop years from October to September, ending in September, 1951. The terms of trade in Table 8 refer to calendar years. In October, 1951, the producer price of cocoa in Nigeria was fixed at an appreciably higher level than in the Gold Coast, hence the divergence.

If I understand him correctly, Dr. Raeburn is apprehensive of the results of a neglect of local food production by producers of export crops if they were to receive the full market value of their exports; and by implication he suggests that local food production ought to be subsidized at the expense of these producers. This seems to imply that boards established to promote the interests of the producers of export crops do so by depressing their incomes, thus driving them into food production for their own subsistence. But while the reduction of the standard of living of these producers is certain, the increased food production is not, for the alternatives to export crops also include production of kola-nuts, petty trading, casual wage earning, dismissal of migrant labour, and an increased drift to the towns.

References to the encouragement of local food production, or to the maintenance of soil fertility, or to the control of inflation as arguments in support of the policies of paying producers less than the commercial values of their products are really in the nature of a retrospective rationalization of these policies. These arguments were not mentioned among the functions of the marketing boards at the time of their establishment (indeed most of the arguments are directly contrary to the aims of statutory marketing as laid down in the Cocoa White Papers), nor were they generally put forward at the time the policies were pursued; and they can hardly serve now as adequate explanation. The absence of any clear idea of the meaning of stabilization, and the failure to distinguish this aim from other aims of policy, has served to encourage such retrospective rationalization, as in these circumstances practically any decision can be justified by reference to one or other of these conflicting aims of policy. But it is better, and safer, to confine discussion to the results of the policies rather than to speculate about the underlying reasons and motives.

I accept Dr. Prest's point that the general rise in prices of West African exports was an important factor in the increase in the rates of export duty in 1950–51. I think that the large surpluses of the boards also played a part. More generally, Dr. Prest suggests that it is inappropriate to consider export duties, which are part of general revenue, alongside the results of statutory marketing. This must be to some extent a matter of judgment. As compulsory levies on producers in their capacity as exporters, export duties seem relevant to a discussion mainly directed to a review of the relation of producer prices to the commercial values of the products. This seems particularly so in view of the fact that export duties at a given percentage of f.o.b. values represent a higher percentage of producer prices when surpluses are accumulated than they do in the absence

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of statutory marketing. This is apart from and additional to the question of the connection between the surpluses and the rates of duty. As export duties are shown separately in all statistics presented in the paper, those who wish to assess them separately and differently from the other items can do so without difficulty.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Gwyn Barcham Aneuryn-Evans.
John Anrep.
John Robert Ashford.
Boyd Ashton.
Peter Richard Avis.
Cyril John Barron.
Maurice Ernest Bates.
Joseph Roger Bell.
Lawrence Sam Berman.
Michael George Bulmer.
Stanley Frederick Burke.
Donald Cameron
Harry William David Chambers.
Dennis Cooke.
Thomas Corlett.
John Critchley.
Bisweswar Das.
Geoffrey Alan Dean.
Pierre Louis Emile Ducros.
John Hilton Edwards.
Jean Daphne Ellison.
Frederic Gordon Foster.
John Kimball Friend.
Santa Ghosh.
Robert Amos Gibson.
Brian Gluss.
Mary Jocelyn Goldsbrough.
Geoffrey Harry Goodger.
William Derek Goodier.
Peter Alan Greenhalgh.
John Hajnal-Konyi.
Betty Irene Harley.
George Henry Hill.
David Wyn Jones.
Evan John Clement Jones.
Jacqueline Jouvin.
Eric Jowett.
Arunansu Kumar Laha.
Denis Leslie Lamberth.
Allan Joseph Lea.
Laurence Henry Luery.
Umrao Bahadur Mathur.
Laurence Millband.
Chandra Mohan.
Philip Moore.
Edward Thomas Mountford.
Malcolm David Mountford.
Kenneth Charles Padley.
Peter Cluver Pirow.
Premsukh Poonai.
James Elliott Pretty.
George Galloway Ridley.
Ronald James Rigden.
John Gerrard Rowell.
Stephan Schattmann.
Geoffrey John Springall.
Vivienne Honor Stamler.
Anthony Sumner.
Ramaswamy Meenatchi Sundrum.
John Sutherland.
Bernard Arthur Morgan Thomas.
Beatrice Edith May Walker.
George Barrie Wetherill.
Oliver Morrow White.
Geoffrey William Wicken.
John Wise.
Hans Gerhard Woyda.
Frederick Ronald Yates.

Corporate Representatives.

Phyllis Mary Briers representing The National Coal Board.
Arthur ap Gwynn representing The Library of the University College of Wales.
Thomas Charles Maynard representing The Westminster Bank Ltd.
Patrick Michael Meaney representing The Joint Clothing Council Ltd.
Peter Tom Ulrich Wykeman representing The British Iron and Steel Federation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

An Essay on the Mathematical Theory of Freedom

By Denis Gabor

Imperial College, University of London

and

André Gabor

The University of Nottingham

[Read before the Royal Statistical Society, December 16th, 1953, the President Sir Ronald Fisher, F.R.S., in the Chair]

Table of Contents

PAGE

Summary 31

I. The Statistical Concept of Freedom

1. Introduction 32
2. Postulates 33
3. The measures of diversity and of independence 34
4. An example: the choice of profession 36
5. The validity and stability of the diversity coefficients 39
6. The validity and stability of the coefficients of dependence 40
7. Statistical freedom and the liberal creed 41

II. Mathematical Part

8. The model 43
9. Conditioned choices 45
10. The constraints 48
11. Mathematical properties of the coefficients of independence . . . 49
12. Correcting the diversity factor by the method of secondary choices . . 52
13. Variation of the diversity factor with statistical grouping 55
14. Variation of the coefficient of dependence with statistical grouping . . 57

SUMMARY

That part of human behaviour which is not rigidly determined by external constraints can be considered as a sequence of more or less free choices. One can talk of a choice only if it is one of several alternatives, and of a free choice only insofar as it is not determined by conditions over which the individuals have no control. Moreover, we recognize an alternative only if it is actually elected by at least a fraction of a population. This leads to the concept of *statistical freedom*. Postulates are formulated which must be satisfied by any numerical measures of statistical freedom, and certain mathematical expressions are proposed which are shown to conform to these postulates. Statistical freedom has two fundamental features, which appear as factors in its numerical measure: *diversity* and *independence*. The measures of diversity and independence are derived in the first place from a certain model of society, but once they are obtained, the model is discarded, and the statistical coefficients are justified by their mathematical properties. Safeguards against arbitrary manipulation of statistical material are discussed, and the potential use of the new measures is illustrated by application to the problem of choice of profession.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

1. The Statistical Concept of Freedom

1. *Introduction*

Freedom, in the sense in which it has its deepest instinctive and traditional roots in the human mind, means the absence of undesirable restraints, hence the concept is almost coextensive with everything which is desirable. We want to show that in the vast domain covered by this powerful but vague idea there exists a field, large and important in itself, which is amenable to quantitative discussion.

Our approach is objective and statistical. It was inspired by Claude Shannon's Theory of Communication (1949), which in turn is based on the statistical concept of communication, first introduced by N. Wiener (1949) and by A. Kolmogoroff (1942).

We call our approach objective, because it is based on observed actions, not on wishes or subjective feelings, and statistical, because it relates to large populations, not to unique individuals. All acts of individuals which we associate with the adjective "free" can be considered as choices from a number of alternatives. Before the act an outside observer can enumerate the possibilities from his necessarily imperfect knowledge of restraints, and he can assess to them probabilities, from his even less perfect knowledge of the psychology of the individual. Actually only one of these possible acts will materialize, and the *a priori* latitude which the observer has granted to the individual appears only as a measure of his own ignorance. Thus the objective approach is useless when applied to the single individual, while a "subjective" approach, based on his own estimate of his wishes, fancies and frustrations can hardly lead to an agreed numerical measure, at any rate not at the present stage of experimental psychology. Moreover, as Dorothy Fosdick (1939) puts it, liberty is the lack of restraint not merely on what men care to do, but on what they *may* care to do.

The objective statistical approach, which takes account only of acts, *post facto*, and which considers the individual only as a member of a large population, overcomes these obstacles at one stroke. We take the view that what the individuals "care to do" or "may care to do" must manifest itself in the actions of at least a fraction of the population. If there is no regulation which forbids bank clerks to wear boiler suits, yet among a thousand bank clerks on a thousand mornings there is not one who appears at work in a boiler suit, we conclude that they are *de facto* not free to wear that garment.

Thus in our view freedom must manifest itself in *diversity*. But this is only one of its features. The other, at least equally important is *independence*. Variety can be enforced, just as well as uniformity.* Our convention will be to recognize freedom only if we find both a statistical spread of behaviour *and* statistical independence of certain social conditions and of other circumstances.

It might appear as if by the last clause we had been forced to fall back on the subjective view of freedom. If asked "of what social conditions must one be independent to be free?" the general answer can be only: "of those which are considered as undesirable in the given civilization". Yet we have not come full circle, but rather in a spiral; the argument is now on another plane, on which agreement is easier than on the level of individual wishes and fancies. There exists in every civilization, at any time, a large measure of agreement concerning the undesirability of certain dependences; one can even say that it is this body of tenets which constitutes the very essence of a civilization. In the Western world for instance, opinion is almost unanimous in condemning slavery and all other forms of bondage which make an individual dependent on the whims of another. The tenets are not all negative. A scientist is not supposed to be indifferent to the opinion of his fellow-experts, while he can scorn the ignorant. The filling of responsible positions on the basis of character and ability is approved, while the dependence of appointments on the economic and social status of the parents is, on the whole, disapproved. It is this body of judgments which gives the terms "desirable" and "undesirable" an agreed meaning, and encourages the hope that quantitative measures based on these judgments may be the objects of fruitful discussion, at least among those who share the tenets of a civilization.

In this essay we will propose numerical measures of freedom and of its two constituent factors: diversity and independence. It may be hoped that the advantages of a quantitative basis for

* The uniforms of the army are in fact far less uniform than civilian clothing, but nobody would interpret the enormous difference between the dress uniform of a general and the battle dress of a private as freedom in clothing.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

discussions will in many cases outweigh those of a free-floating concept of freedom, which anybody can twist or turn to prove his own point.

2. *Postulates*

The problems which we propose to consider present themselves in the following general form: the individuals in a given population, in a certain interval of time make a number of decisions, such as political vote, choice of goods purchased, choice of occupation, etc. It will simplify the discussion if we assume that the choices are *discrete*. Assume that we have ordered these decisions in "*lines*", for instance let the political vote be one line, the choice of newspapers a second, and so on. The selection made by one individual can then be specified by a set of integers, $i_1, i_2 \ldots$ where i_1 for instance identifies his political party, i_2 his newspaper, etc. We assume that the classification is such that each individual appears once in every line, and once only. As for instance one man can read several newspapers or none, the line specifying newspapers must provide classes for any combination of papers, and every line must contain "no choice" as an alternative. All these simple choices $i_1, i_2 \ldots$ can be considered as forming one composite choice i.

In addition we specify the condition of the individual by a number of "*factors*", such as age, income, domicile. These again will be considered as discrete and represented by integers $j_1, j_2 \ldots$ to which we will refer as "data". The distinction between choices and data is not absolute. The occupation, for instance, is subject to choice if the period considered is a lifetime, but it is a datum in a short interval of time. The data $j_1, j_2 \ldots$ taken together form a composite datum j.

The population is fully described statistically if we know the fractions of the population who have made the choice i in condition j, for all i, j. We denote these fractions by $p(i, j)$, short for $p(i_1 \ldots, j_1 \ldots)$, and call them the "*qualified preferences*". If we disregard the condition j, that is to say if we count the fraction of the population which has made a certain choice i, irrespective of their condition, we obtain

$$p(i) = \sum_j p(i, j).$$

The fractions $p(i)$ will be called simply "preferences".

We can also ignore a part of the factors, and any number, short of their total number, of the lines of choice. All these partial descriptions are contained in the most complete description $p(i, j)$; they are obtained by summing the $p(i, j)$ over the ignored co-ordinates. It may be noted that the $p(i, j)$ are of the type as obtained in family budget enquiries; they contain the complete record of the actions and of the condition of any individual in the field of discourse, though the individuals remain anonymous.

Our problem is now this. Given the qualified preferences $p(i, j)$ we want statistical coefficients, constructed from these, which can be considered as measuring the freedom of the average individual of the population, subject to the conditions j. In trying to establish such measures we shall be guided by the following general postulates.

1. If all members of the population have made the same choice, we consider their freedom as *nil*.
2. We consider the freedom still as zero if there is variety in the choices, but the variety is uniquely determined by factors not subject to choice.
3. In all other cases freedom must be a positive quantity.
4. The measure of freedom must never be increased by taking into consideration factors previously ignored.
5. The measure must be independent of or at least insensitive to some degree of arbitrary re-ordering or re-classification of the statistical material.

These are conventions, open to discussion. We have already advanced the argument regarding 1. Convention 2 appears equally natural, though on closer inspection it seems to lead to the question of "determinism or free will?" with which we propose to deal presently. The third convention is an important limitation of the field of discourse. As will be discussed in more detail in Section 7, the current idea of freedom includes, very rightly, freedom from the fear of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

war, want and bondage. These mean not only deprivation of free choice, but the danger of being forced to do and to suffer actions which nobody would undertake or endure if he had any small degree of free choice. We do not of course deny the importance of these liberties. They form a complement to our interpretation of freedom; the exclusion of hateful contingencies may be as important as the increase of desirable variety, but we consider this component of freedom as below our zero level, and unmeasurable.

Postulate 4 will be our most important guide in finding a suitable measure of freedom. It involves neither more nor less than the fundamental hypothesis of natural science, that the more one knows about a system, the better one can predict its behaviour. Whether in the end, when we have taken all circumstances into consideration there will be any "free will" left is an old and vexed question, and it is worth noting that it never arises in a statistical approach. Human beings are highly complex, and their circumstances can never be reproduced exactly. If we go on specifying them closer and closer, long before we have arrived at the limit allowed by quantum physics our sample will have shrunk to *one* individual and the *statistical significance* of the results to *nil*.*

Like most human concepts, freedom is valid only between certain limits of analysis, but there is never any practical danger of coming up against these limits if the problems are reasonably formulated. Human freedom is not independence of everything; it does not mean for instance independence of one's heredity, or physico-chemical make-up, or of the laws of nature. It means independence of those conditions which are considered as undesirable, and we must now add, *avoidable* in a given civilization. Though progress in the natural sciences has theoretically restricted the limits of human will, practically it has expanded them to an enormous extent, and has enabled us to consider starvation and many forms of illness as avoidable evils, whose elimination is well within the limits of human competence. Liberty in the practical sense is not threatened by scientific determinism.

Postulate 5 is evidently of great importance. To some extent it is safeguarded already by the formulation of the problem, as the re-numbering of the co-ordinates has no influence on the preferences $p(i, j)$, from which the measures are calculated, but many problems arise some of which will be discussed in subsequent sections.

The postulates evidently do not define a unique measure of freedom. For example, once a measure satisfying the postulates is found, any positive monotonic function of it would serve equally well.

3. *The Measures of Diversity and of Independence*

In the mathematical part the statistical coefficients which we propose for the measure of freedom, variety and independence, are derived from an idealized model of society. Without this model the interesting mathematical properties of the new statistical coefficients might have been difficult to discover, but though the model is not without interest in itself, once it has done its duty it can be discarded, and the coefficients must stand on their own merits. We therefore introduce these coefficients first as *definitions*, leaving their derivation for later.

The statistical freedom of an individual regarding the choice i, qualified by the condition j may be defined as

$$f_{i,j} = D_i (1 - \varepsilon^2_{i,j}). \qquad (1)$$

The freedom coefficient $f_{i,j}$ appears as the product of a variety or *diversity factor* D_i and of an *independence factor*, which we have written in the form $1 - \varepsilon^2_{i,j}$ in order to bring it in line with the coefficients of contingency used in statistics. $\varepsilon_{i,j}$ may be called the *coefficient of dependence*. Equation (1) expresses in the simplest possible mathematical form our contention that diversity and independence must be simultaneously present to produce the phenomenon which we recognize as freedom.

We define the diversity D_i relating to the choice i as

$$D_i = -1/\sum_i \frac{p(i)}{\log p(i)} \qquad (2)$$

* Cf. the interesting study by Warren Weaver, "Statistical Freedom of the Will", *Rev. Mod. Phys.* (1948), **20**, 31.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It is easy to see that this is a measure of the variety of choice, simple or composite. Expression (2) has properties similar to Shannon's "entropy" (1949, p. 19).

$$H = -\sum_i p(i) \log p(i).$$

Like the entropy, D_i is never negative, and zero only if there is only a single possibility, that is to say if there is no choice. In this case $p(i) = 1$ for one i, zero for all the others. Another property which D_i has in common with H is that it has a maximum if and only if all the preferences are equal, that is to say if the population is evenly distributed over the choices.

It appears convenient to standardize the diversity factor in the same way as H has been standardized in communication theory, that is to say by adopting 2 as the basis of the logarithms. On the other hand the terms "bits" or "binits", short for "binary digits", which are used in Communication Theory for the measure of information do not appear to be very suitable names for the unit of diversity. We propose instead "*one dual*", considering as the unit of comparison a population which has distributed itself 50–50 between two alternatives. Fig. 1 shows the two

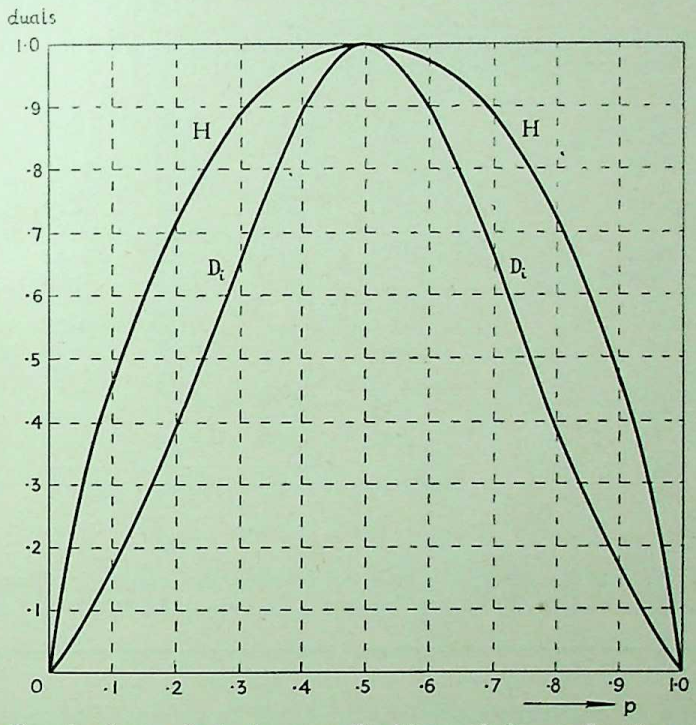


FIG. 1.—The diversity factor D_i in the case of a binary choice, as function of the fraction p of the population which has elected one of the alternatives. Shannon's "entropy" H is shown for comparison.

functions D_i and H for a binary choice, as a function of the fraction p which has elected one of the two. It is seen that the diversity factor has a much sharper maximum than the entropy.

As an illustration, Fig. 2 shows the variations of the diversity factor in the parliamentary vote in British general elections from 1931 to 1951. It is seen that in the last election it has come within 8 per cent. of one dual, by the strength and almost perfect balance of the two dominant parties, and the corresponding decay of the others.

The coefficient of dependence $\varepsilon_{i,j}$ is defined by

$$\varepsilon^2_{i,j} = -\sum_i \sum_j \frac{p(i,j)}{\log p(i)} \log \frac{p(i,j)}{p(i)\,p(j)}, \quad . \quad . \quad . \quad . \quad (3)$$

with the notations

$$p(i) = \sum_j p(i,j), \qquad p(j) = \sum_i p(i,j). \quad . \quad . \quad . \quad . \quad (4)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

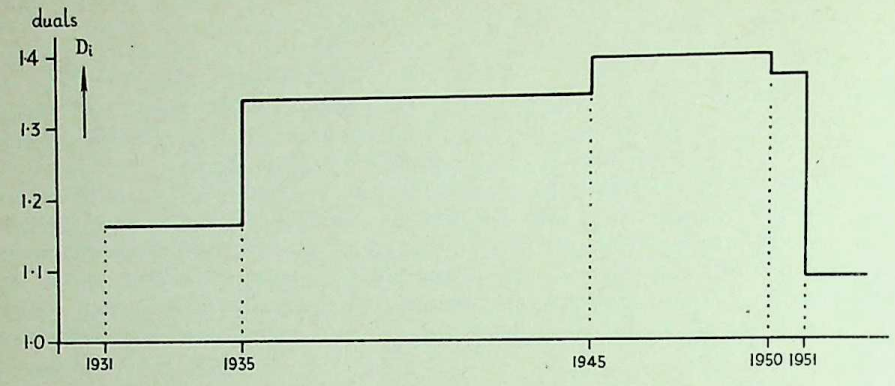


FIG. 2.—The diversity factor D_i in general elections to Parliament, Britain, 1931–1951. The figures are based on the following percentages of votes:

Election year	1931	1935	1945	1950	1951
Conservative	54·70	47·67	34·75	38·81	48·04
Labour	30·60	37·84	47·91	46·11	48·76
Nat. Labour	1·57	1·55	—	—	—
Liberal	6·14	6·26	9·01	9·11	2·53
Liberal Nat.	4·01	3·94	3·04	3·42	—
Ulster Unionist	—	—	1·76	1·23	—
Scottish Nat.	—	—	0·12	0·04	0·03
Irish Nat.	—	—	0·59	0·22	0·30
Welsh Nat.	—	—	0·06	0·06	0·04
Ind. Labour	—	0·63	0·14	0·02	0·01
Communist	0·35	0·12	0·41	0·32	0·07
Independent	0·46	0·99	1·15	0·39	—
Others	2·17	1·00	1·06	0·27	0·22
	100·00	100·00	100·00	100·00	100·00
D_i	1·163	1·335	1·387	1·360	1·080 duals

The application of equation (2) to this material involves the assumption that all the votes cast represent first choices. This would be strictly true in the case of proportional representation only.

It is not evident from its mathematical form, but it will be proved in Section 9 that its value is always between the limits zero and unity. It is unity if and only if the choices i are uniquely determined by the conditions j, which brings it into conformity with our second postulate, and it is zero if and only if the i are completely independent of the j.

The most important mathematical property of the coefficients of dependence is that *they are never decreased by qualification of the conditions.* That is to say if a new factor is taken into consideration, the freedom thus calculated is never more than if the factor is ignored. By this our definitions (1)–(3) conform with postulate 4.

4. *An Example: The Choice of Profession*

We want to show now, in a first, not quite elementary example, how these coefficients may be employed in studies of social freedom. Free choice of profession is one of the liberal tenets in our civilization. It is of course admitted that the choice need not be free to anybody, only to those of the right qualifications, but the father's social status is not considered as the right qualification. Discussions on these questions are complicated by the fact that the fathers may have gained their status by their merits, and these may be transmitted by heredity or by environmental

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

influence. Thus the liberal creed can be stated more exactly as follows: *Given the qualifications of the individual, it must not matter who his father is.*

Our formulae enable us to give an answer to the question "how strong is the influence of the fathers in determining the profession of their sons, apart from transmitting their ability to them?" and to numerous other questions which arise in connection with the choice of profession. We discuss these in the case of the imaginary example given in Table 1.

Four professions $i = 1, 2, 3, 4$ have been assumed, thus the maximum diversity would be 2 duals. Owing to uneven distribution the table gives $D_i = 1{\cdot}69050$ duals, which is 84·5 per cent. of the maximum.

TABLE 1

Contingency Table of Profession, i, *Ability Group*, j_1, *and Father's Profession*, j_2

The example is imaginary. Four professions are assumed, 1–4, and four ability groups. The table shows the fractions $p(i, j_1 j_2)$.

Son's profession i	*Father's profession* j_2: 1	2	3	4	*Ability group* j_1
1	·16	·04	·03	·01	1
	·08	·03	·01	—	2
	·02	·02	—	—	3
	—	—	—	—	4
	·26	·09	·04	·01	·40
2	·03	·03	·03	·01	1
	·03	·06	·02	·01	2
	·02	·04	·01	—	3
	—	·01	—	—	4
	·08	·14	·06	·02	·30
3	—	—	—	—	1
	·01	—	·02	·01	2
	·02	·03	·03	·02	3
	·01	·02	·03	—	4
	·04	·05	·08	·03	·20
4	—	—	—	—	1
	—	—	—	·01	2
	—	—	·01	·01	3
	·02	·02	·01	·02	4
	·02	·02	·02	·04	·10
	·40	·30	·20	·10	

If the ability group j_1 of a man is known, the freedom coefficient f_{i, j_1} is obtained by multiplying D_i with the independence factor $1 - \varepsilon^2_{i, j_1}$. We find

$$\varepsilon_{i, j_1} = 0{\cdot}49668, \qquad \varepsilon^2_{i, j_1} = 0{\cdot}24669,$$

and the independence factor is $1 - 0{\cdot}24669 = 0{\cdot}75331$. Hence the ability determines 24·67 per cent. of the choice and reduces the coefficient of freedom to

$$f_{i, j_1} = 1{\cdot}69050 \times 0{\cdot}75331 = 1{\cdot}273 \text{ duals.}$$

If fathers had no influence on the professions of their sons other than by transmitting their ability, by heredity or by environmental factors, the coefficient of dependence $\varepsilon_{i, j_1 j_2}$, where j_2 is the profession of the father, would be the same as ε_{i, j_1}. We find

$$\varepsilon_{i, j_1 j_2} = 0{\cdot}62326, \quad \varepsilon^2_{i, j_1 j_2} = 0{\cdot}38845,$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

which reduces the freedom of choice to

$$f_{i,\, j_1 j_2} = 1{\cdot}69050 \times 0{\cdot}61155 = 1{\cdot}034 \text{ duals.}$$

The reduction is 0·239 duals, or about 18·77 per cent. of the freedom which would have existed without "direct" influence of the fathers.

Whether a figure calculated in this way will be accepted in an actual case as a fair estimate depends of course, among other things, on the confidence which we put in ability tests such as I.Q. tests or school examinations. Assuming that agreement is reached on this point, the further question arises whether this "direct" influence of the fathers is socially or morally justifiable or not.

It can be argued, that the maximum social utility may not be reached at the point when fathers have no direct influence. The ability of successful fathers to improve the prospects of their sons can be considered as part of the compensation which society pays for their services, and it is an incentive whose complete abolition might do more harm than good. To this one might reply that the ability of the upper brackets to smooth the careers of their sons may be desirable in itself, but unfortunately it is possible only at the expense of the lower brackets. This is a typical case of the *clash of liberties*, in which we do not want to take sides, but merely want to indicate how numerical data can be gained as a basis for further discussions.

Our formulae do not know of "upper" and "lower" income brackets, professions or abilities. They would give the same result every time so long as there are specified groups, with the given populations. Consequently the difference

$$\Delta = \varepsilon^2_{i,\, j_1 j_2} - \varepsilon^2_{i,\, j_1} = 0{\cdot}14176$$

which we have called the direct influence of the fathers appears as the sum of *positive* contributions from all classes $j_2 = 1 - 4$ of fathers. This influence manifests itself in giving the sons of a class, at given ability, a distribution over the professions different from the overall average. Consider, e.g., 1 as the "lowest" profession and 4 as the "highest". Both make a contribution to this influence by keeping a relatively high proportion of their sons in their own class. The social moralist will have no difficulty in labelling these as "hardships or benefits" according to the more or less generally accepted social scale, and as "good or bad" according to his own convictions. What the statistician can do is only to localize these influences and to give them numerical values; their labelling must be left to the sociologist or social reformer.

Our coefficients of dependence (in their squared form), are additively composed of the contribution of population groups, hence, as shown in detail in the mathematical part, it is possible to allocate to each group a share in the influence. In the present case we can decompose Δ into the contributions $\Delta(j_2)$ of the four professions j_2 of the fathers and obtain

Father's profession (Class) j_2	1	2	3	4
Class influence $\Delta(j_2)$ . . .	0·05461	0·03558	0·02022	0·03135
Influence factor $\Delta(j_2)/p(j_2)$ . .	0·1365	0·1186	0·1011	0·3135

If class 1 is the "lowest", 4 the "highest", the influences of the two highest classes will be presumably considered as benefits, the influence of the first class as a hardship; the line between these runs somewhere through class 2. The last row shows the "influence factors", i.e., the influences of the classes per unit population, which in this case is largest for the "highest" class.

It may be seen from this example that significant statistical coefficients can be obtained only from trivariate tables, and such material is only rarely available in published form. Tables containing only two of the variates are no substitute, even if they cover all possible combinations, and the conclusions drawn from these may be seriously misleading. It is therefore very regrettable that so much statistical material, potentially of great interest for social analysis, is broken down for presentation into bivariate or even univariate form.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5. *The Validity and Stability of the Diversity Coefficients*

One of the most important considerations in judging the value of statistical coefficients is their stability against arbitrary manipulation of the numerical material. It is well known that no statistical coefficient can fully satisfy this condition, nor the related criterion of validity under widely different circumstances. Cost of living index numbers, for instance, can be used for comparison only within certain narrow limits of time, and only for civilizations which show a high degree of similarity. The coefficients which we propose for the measure of freedom form no exception. Evidently, if one observer insists on recognizing one group of choice only where another recognizes four, the first will find a diversity factor zero, while the other might find up to 2 duals. Some measure of agreement regarding the grouping of the statistical phenomena must be reached before the problem of measurement has any meaning.

There are certain cases in which the grouping appears so natural that it might seem at first sight that agreement can be reached without a question. Examples of this type are political votes, and the choice of branded articles, such as newspapers or toothpastes. A political party or a newspaper is indeed in a sense an elementary unit; one must vote for it or buy it as a whole, no subdivision is possible. Yet, a critical observer might object that if the parties or the newspapers differ only in name, or the toothpastes only in the label, there is really no choice. This is a pertinent objection, but it takes no account of the fact that even if the toothpastes could be proved identical by chemical analysis, the purchasers may still have a subjective feeling of free choice, which objectively expresses itself in their different preferences. We therefore propose a method of purifying the raw statistical material by a process based on *secondary choices*, which is described in Section 12. This is a process of lumping together those fractions of the population, whose different choices can be attributed to indifference rather than to real preferences.

The method of secondary choices enables us to meet the objections in the case of elementary choices which cannot be subdivided, but can be lumped. Objections of a different kind arise if the choices are capable of subdivision, especially if they are divisible beyond any limit. This is the case if the choices are ordered in terms of one or several numerical *variables*, such as money, weight, etc. Different subdivision, applied to the same statistical material will give, in general, different diversity coefficients. Hence either some special convention must be adopted, or the previous definition must be modified if we want to secure sufficient stability of the diversity factor.

If the aim is to obtain figures which are internationally comparable, the units of the variables x must be international units, such as money in terms of exchange parity, or in terms of wage-hours, or corrected for cost of living; numbers of cigarettes, pounds of soap, etc. Then it matters little what units are adopted, and what number of these is taken to represent one statistical group, so long as the same units *and* the same groups are applied in the analysis of all the populations between which comparisons are made. If these two rules are observed, all definitions for the case of discrete variates can be retained when dealing with variables x.

We can drop, however, the stipulation of equal subdivision, while retaining internationally comparable units, if we modify the definition of the diversity factor in a way as shown below, provided that the subdivision is "*fine enough*".

Assume that with refined subdivision, i.e., with intervals $x_2 - x_1$ decreasing, the fraction of the population inside the limits x_2, x_1, divided by the interval $x_2 - x_1$ tends to a limit $P(x)$. The convergence to the limit is to be understood in a "semiconvergent" sense, that is, the interval $x_2 - x_1$ does not tend to zero, but only to a value small enough to make the details of the distribution inside it unimportant, yet $x_2 - x_1$ must be large enough to contain a significant number of individuals. This is the general condition for the application of continuous analysis to the statistics of individual phenomena. With this *grano salis* we now define the diversity factor for arbitrarily subdivisible variables x as

$$D_x = -1 \Big/ \int \frac{P(x)\,dx}{\log P(x)}, \qquad \left(\int P(x)dx = 1\right). \quad . \quad . \quad . \quad (5)$$

The passage from equation (2) to equation (5) is essentially the same as the step taken by Shannon (1949, p. 54) in passing from the definition of the entropy of a discrete source

$$-\Sigma\, p(i)\, \log p(i)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to the entropy of a "continuous" source

$$-\int P(x)\ \log\ P(x)dx.$$

Assuming that the unit of x has the required properties of international or temporal invariance, we can now make comparisons between two populations, using any sort of subdivisions, provided that they are fine enough in the sense described. A further condition is that the unit of x must be chosen so small that even at the finest subdivision considered P can never attain the value unity. It is of course understood that an exact value of the integral in equation (5) does not exist, but there is a wide range of subdivisions in which the sum which it represents is insensitive to the division, if the samples are large enough. The accuracy itself can be estimated by computing in addition to the value at the finest subdivision one which is half as fine and preferably also one twice as fine. Assuming that one operates in the range in which D_x steadily increases with n, the difference between the values at n and at $\frac{1}{2}n$ can itself be taken as a measure of the accuracy.

It is understood that the values D'_x, D''_x calculated for two populations are still dependent on the (common) unit adopted in computing them. For instance if we find one population evenly distributed over an interval X', the other over X'', the diversity factors will be log X' and log X''. But one can say, quite independently of the unit of x that the second population has $\log_2 X'' - \log_2 X' = \log_2 X''/X'$ more diversity than the first.

It is seen that the difficulties of obtaining comparable values for diversity factors are neither greater nor less than those encountered in all international or long-term statistical comparisons. They are entirely reduced to the problem of finding comparable units.

6. *Validity and Stability of the Coefficients of Dependence*

Once a convention regarding the unit of x has been made, the factor j which occurs in the coefficients of dependence raises no further difficulties. These coefficients possess two important properties, proved in the mathematical part:

1. *The coefficients of dependence are never decreased by a finer subdivision of the factors, and approach an upper limit.*

2. *With a finer subdivision of choices the coefficients of dependence may increase at first, but they decrease if the subdivision is pushed so far as to reveal indifference to the finer distinctions. There exists therefore a certain subdivision which reveals the largest or maximum dependence.*

Both are properties which one is justified in postulating for any acceptable measure of dependence. It must be expected that if one considers the factors in more detail, in general stronger dependence will be revealed. This is a generalisation of the postulate that the addition of a previously ignored factor must never decrease the dependence. On the other hand, if we adopt a more detailed classification of the choices, the coefficient of dependence may increase at first, as we might have started from a coarse grouping which showed independence.* But if we proceed with the subdivision, we must expect to find, in general, that the factors do not govern the detailed choices of the population as rigidly as they govern its large-scale distribution. It follows that if we classify the choices in more detail the coefficient of freedom, $f_{i,\ j}$ will increase for two reasons; both the diversity and the independence factor will become, in general, larger. These effects are illustrated in Table 2 in the example of the choice of profession, discussed in Section 4.

The divisions in this example are rather coarse, yet it is noteworthy that even the small difference $\Delta = \varepsilon^2_{i,\ j_1 j_2} - \varepsilon^2_{i,\ j_1}$ which expresses the direct influence of the fathers, and which is 0·14176 in the $4 \times 4 \times 4$ table is found to be 0·12308 in the $2 \times 2 \times 2$ table; a relatively small difference. As may be expected, the effects of subdividing the choices and subdividing the factors largely cancel one another.

It is important to note that if the classification of the choices i is fixed, finer subdivision of the factor j will not produce an appreciable difference beyond a certain limit. This, in conjunction with 2. suggests the practical rule: when in doubt regarding the grouping, adopt the finest subdivision.

* We had overlooked this at first, and we are grateful to Professor Champernowne for having pointed it out in the discussion.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

The Variation of the Coefficients of Diversity and of Dependence with the Classification, in the Problem of Choice of Profession

i = profession of sons. j_1 = ability group of sons. j_2 = profession of fathers.
n_1, n_{j_1}, n_{j_2} are the numbers of groups distinguished in i, j_1, j_2.
In the cases with twofold division, groups 1, 2 and 3, 4 have been merged.

$n_i \times n_{j_1} \times n_{j_2}$	$4 \times 4 \times 4$	$2 \times 2 \times 2$	$4 \times 2 \times 2$	$2 \times 4 \times 2$	$2 \times 2 \times 4$
D_i	1·69050	0·65228	1·69050	0·65228	0·65228
ε^2_{i,j_1}	0·24669	0·30008	0·16389	0·42534	0·30008
ε_{i,j_1}	0·49668	0·54779	0·40483	0·65218	0·54779
ε^2_{i,j_2}	0·11548	0·10492	0·06320	0·10492	0·12067
ε_{i,j_2}	0·33982	0·32391	0·25140	0·32391	0·34738
$\varepsilon^2_{j_1j_2}$	0·03112	0·01232	0·01232	0·00708	0·04447
$\varepsilon_{j_1j_2}$	0·17640	0·11098	0·11098	0·08415	0·21088
ε^2_{i,j_1j_2}	0·38845	0·42316	0·23771	0·55508	0·44566
ε_{i,j_1j_2}	0·62326	0·65051	0·48756	0·74504	0·66758
$\varepsilon^2_{i,j_1j_2} - \varepsilon^2_{i,j_1}$	0·14176	0·12308	0·07382	0·12973	0·14558

division of the factors available, and that grouping of the choices which gives the largest value for the coefficient of dependence.

In this essay there is no space for discussing the effects of sampling fluctuations on the new statistical coefficients, which would require a special study.

7. *Statistical Freedom and the Liberal Creed*

"There is no word that admits of more various significations and has made more varied impressions on the human mind than that of Liberty". These words of Montesquieu (1914), true enough in their time, are much more so to-day, after another 200 years of disguises and distortions. It is truly surprising that in spite of all the efforts of philosophers as well as of politicians to turn the meaning of freedom into its opposite, the emotional value of freedom has remained unimpaired. No civilization, however perverted, has yet been known in which "a free man" could have been used as an evil byword. Freedom is still the greatest of battle cries, though it can be used in almost any conflict by both sides.

We will not attempt to go into the analysis of the various contradictory interpretations of this protean concept. This has been done brilliantly by Dorothy Fosdick (1939), and more recently by Maurice Cranston (1953). It will be sufficient if we try to clarify the standing of the concept of *measurable* statistical freedom with respect to those interpretations which, in full agreement with Dorothy Fosdick, we consider as legitimate.

An authoritative declaration of the fundamental liberties was given by Lord Beveridge (1944): "*Freedom from War and fear of War, Freedom from Want and fear of Want, Freedom from Idleness and fear of Idleness enforced by unemployment*, these are the fundamental freedoms. These are the aims which we should pursue with unrelenting determination both during the war and after it."

To these Lord Beveridge adds a list of the essential citizen liberties: "Freedom of worship, speech, writing, study and teaching; freedom of assembly and of association for political and other purposes, including the bringing about of a peaceful change of the governing authority; freedom in choice of occupation; and freedom in the management of a personal income".

Comparing these liberties with our concept of freedom, whose two essential features are diversity and independence, it is clear that neither of the fundamental freedoms is a measurable freedom, but only an indispensable pre-requisite for it. Slavery, war, want and enforced unemployment

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

are not only negations of free choice, but imply coercion into lines of action which, according to the liberal creed, nobody would adopt if he had a free choice. The four fundamental postulates ensure only that freedom does not fall below the *zero level*, where the concept of measurable freedom just starts. By this we do not deny, but on the contrary, assert the priority of the fundamental liberties. Without them there can be no measurable freedom.

We see no advantage in extending the concept of measure to negative values, in the way as the theory of utilities has been extended to disutilities. One reason is that it is unlikely that the work of the statistician in this direction could be socially important. "Sub-zero freedom", that is to say bondage or the fear of bondage, produces healthy reactions in our civilization, almost as spontaneous and instinctive as the jerkings of a fox caught in a trap. If ever this instinct should be weakened, it will be a matter for the gifted orator and for the poet, rather than for the man of numbers, to awaken it and to ask for sacrifices far beyond the rational limit. It was this most elementary of freedoms, the freedom from chains, which inspired Shelley's "Ode to Liberty" and his "Men of England". On the other hand the freedom of choice which women in the lower income brackets enjoy in the popular chain stores, however important it may be for our civilization, will certainly find no Shelley to sing its praises. It is in this region, less safeguarded but also less obscured by emotions, where the statistician can do useful work by providing the administrator and the legislator with numerical measures of social phenomena.

Freedom from fear has been rightly emphasized by Beveridge in connection with every one of the fundamental freedoms. When fear is present, great caution must be exercised in any approach such as ours which is based on revealed preferences, even if the analysis is extended so as to take into consideration, along with the conditions j, the *consequences* k of the actions. Every such approach is very likely to fail for the reason of man's intelligent anticipation. One single case of a journalist who has been sacked for writing something contrary to the views of the owner of his newspaper might prevent all the others from attempting it. A similar case arises here as if one found that only one packet has been sold of a certain brand of cigarettes, and concluded that it was unpopular, while in reality it was very popular, but there was only one packet for sale, and the first action of buying has prevented all the others. If we know of the scarcity of the brand, we can exclude it from the statistics, but if we do not, we cannot distinguish the effects from those of unpopularity. In the case of fear the problem is more difficult, because the one case of unpleasant consequences may have happened before the period to which the statistics relate, or it may not have happened at all; intelligent anticipation of the reactions of their employer may have prevented the journalists from making use of their formal freedom.

For these reasons we cannot, without further data, account for the freedom from or the dependence on fear separately, on the basis of a distribution $p(i, j, k)$. This of course is very well known, and much used by the enemies of liberty. Whenever the threats of unpleasant consequences are sufficiently hidden, they will claim that the restricted actions are voluntary; the population simply did not want to make use of their nominal freedom. They are seldom as candid as Goebbels who said that anybody can write what he likes if he is not afraid of the concentration camp.

In such cases the statistical method cannot go far. Generally even the data required for calculating the qualified preferences will not be available. Only in a society which is sufficiently free to allow an enquiry into its own freedom is it possible to go a step further. In such a society confidential polls can be arranged, in which the population are asked what choices they would have made if this or that unpleasant consequence were eliminated. By comparing this "potential" distribution with the actual it may be possible to obtain quantitative estimates of the restrictive influence of certain fears.

Among the essential citizen rights as listed by Beveridge only the last two—freedom of choice of occupation, and freedom in the management of personal income—can be said to be sufficiently free from more or less secret fears for enabling the investigator to disregard fear as a factor, and this is why we have chosen the first as our main example. As regards the second, increasingly detailed budgetary material is now becoming available in several countries, and we propose to come back to this problem on another occasion.

While freedom is one of the strongest human urges, and while we have emphasized choice as an indispensable element of freedom, we do not assert for a moment that choosing is always a pleasurable act. One can even say that the hesitation between choices is seldom a pleasure. Everybody knows that for many housewives selecting the daily menu can be a worry amounting to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

torture, and they eagerly welcome suggestions for composing the meals. On the other hand, the mere existence of possibilities which one never thinks of choosing may be a source of satisfaction. The length of the wine list in elegant restaurants, made up mostly of expensive items which are rarely if ever chosen caters for this curious psychological need. Forbidding choices which are never made use of, such as the freedom of bank clerks to wear boiler suits may have a profound effect on the subjective feeling of freedom. This is one of the many points in which the *post facto* statistical treatment cannot follow the queer workings of the human psyche.

The concept of freedom covers almost the whole of civilized life, and it is too early yet to say what aspects of it will be found suitable for quantitative discussion. We certainly do not expect that all the legitimate uses of the concept, of which we have mentioned a few only, can be made quantitative. To mention one obvious limitation; the freedom of the exceptional creative individual may be of the greatest importance for the organic development of society, yet the statistical approach by its very nature, can take little account of the individual exception. We have no wish to join the ranks of those numerous authors who wanted to monopolize the word "freedom" for their own interpretation.

II. Mathematical Part

8. *The Model*

Consider a population faced with a set of discrete choices i. The choices i can be composite, representing a complex of simple choices, each expressed by a number $i_1, i_2 \ldots$, as explained in Section 2. For a start we will ignore the conditions j of the individuals, and describe the distribution over the choices by the preferences $p(i)$, whose sum is unity.

With each choice i we associate a utility coefficient U_i, which for the moment may be left undetermined, and we define a *utility function* U as the sum of utilities per head of population

$$U = \Sigma\, U_i p(i). \qquad (6)$$

If we consider the utility coefficients as given, U is a function of the distribution. (The coefficients U_i should not be interpreted as corresponding to any of the utility concepts of economists.)

If we had a *pure* population and no restrictions, we should expect that only one of the choices would be elected by the whole population; the one with the largest U_i. Actually the population is inhomogeneous, subject to conditions which are different from individual to individual, and this will manifest itself in a spread over at least some of the possible choices. As a convenient mathematical expression for this spread we introduce the *freedom function*

$$F = -\sum_i U_i p(i) \log p(i), \qquad (7)$$

where *log* stands for the natural logarithm. F arises from Shannon's entropy function

$$H = -\sum_i p(i) \log p(i)$$

by weighting with the utility coefficients U_i. If these are all positive, the function F, like H, will never be negative, and zero only if one of the $p(i)$ is unity and all the rest zero.

It will now be shown that the actual distribution $p(i)$ can be interpreted as the result of maximizing a function

$$\Phi = U + CF, \qquad (8)$$

where C is a constant which may be left undetermined for the moment. Φ will be called the "*social potential*". In maximizing it we must take into consideration the auxiliary condition

$$\sum_i p(i) = 1.$$

A necessary condition for a conditional maximum is that the derivatives of the function

$$\Phi' = U + CF - \Lambda \sum_i p(i)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with respect to the variables $p(i)$ must all vanish. Λ is a Lagrangean undetermined multiplier. This condition gives as many equations as there are choices, of the form

$$\frac{\partial \Phi'}{\partial p(i)} = U_i [1 - C - C \log p(i)] - \Lambda = 0.$$

Hence, if we knew the utilities, we could calculate the distribution from

$$p(i) = \exp - \left(\frac{C-1}{C} + \frac{\Lambda}{CU_i} \right) \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and determine the multiplier Λ from the condition

$$\sum_i p(i) = e^{-(C-1)/C} \sum e^{-\Lambda/CU_i} = 1.$$

On the other hand we can account for the observed preferences $p(i)$ by assuming certain utility coefficients, obtained by inverting equation (9).

$$U_i = - \Lambda/[C - 1 + C \log p(i)]. \quad . \quad . \quad . \quad . \quad (10)$$

This is the general solution, but it can be easily seen that if we want the coefficients U_i to correspond to the concept suggested by the term "utility" it is necessary to specialize to $C = 1$. We want all U_i to be positive. But if we choose a C larger than unity, U_i, as given by equation (10), will pass through infinity and reverse its sign at a critical value $\log p(i) = - (C - 1)/C$. On the other hand if we make C smaller than unity, though the utilities have now all the same sign the difficulty arises that U_i has a finite value for $p(i) = 1$. It is contrary to our intuition to attribute a finite and arbitrary value to a utility which is so attractive that it concentrates the whole choice on itself. We can escape this dilemma only if we make $C = 1$. This will be assumed in all the following formulae, and it may again be noted that unless otherwise stated we operate always with natural logarithms. Thus we write now

$$U_i = - \Lambda/\log p(i). \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

The multiplier Λ must be positive, but remains otherwise undetermined.

Formally the inversion which led to equation (11) is always possible, but it is important to note that it is not always meaningful. We cannot interpret a distribution as having arisen by maximizing Φ or any other function unless we know that there were no constraints active which would have prevented a small variation upwards or downwards from the observed value. If, for instance, the choice is the acquisition of a commodity, and the supply of the commodity i was exhausted at the actual value $p(i)$, the interpretation as a maximum is evidently not admissible. Φ may still be the largest value compatible with the conditions, but it is not a maximum. Such rigid limitations must be therefore excluded in this section and also in those which follow.

Substituting the values of the U_i from equation (11) into equations (6) and (7), we now obtain the values of the functions U and F, which may be termed the "*aggregate utility*" and the "*aggregate freedom*" per head of the population

$$U = - \Lambda \sum_i p(i)/\log\ p(i), \qquad F = \Lambda. \quad . \quad . \quad . \quad . \quad (12)$$

Both are determined only up to an arbitrary factor. The ratio of freedom to utility on the other hand is fully determined, and is (cf. equation (2))

$$D_i = F/U = - 1/\sum_i \frac{p(i)}{\log p(i)}. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This is a quantity which measures the *diversity* in the choices of the population. It is zero if the whole population has elected one only of the alternatives, and it is a maximum, equal to $\log r$, if the distribution is uniform over all n possibilities.

It is evident that we have not proposed here any theory of social phenomena, only an alternative complete mathematical description of the actual distribution. We have, however, chosen suggestive

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

names for the mathematical quantities, "utility", "freedom" and "social potential", which require some justification. They suggest that if we knew the utility coefficients, a dynamical model of a society could be constructed, characterized by a tendency to maximize a certain function. This could then rightly be called a "social potential", by analogy to the thermodynamical potentials which are used for describing the behaviour of complicated physical systems in statistical thermodynamics.* Such a justification cannot be attempted at this stage, because we require just as many utility coefficients for the "explanation" as there are preferences. In the next section the method will be applied to "qualified" preferences, and it will then be found that the number of utility coefficients is much smaller, but an equal number of "constraints" must be introduced to account for the actual distribution. Hence even this is not a theory, in the proper meaning of the term. If, however, this analysis were applied to a great variety of statistical distributions, and if it were found that the utilities and constraints follow simple laws, it might be possible to take the step from a method of description to a theory of social dynamics. It must not be thought that such a proceeding would be essentially different from the method of the physical sciences. It is true that the utilities are not measurable except by their effects on the distributions, but neither are the forces measurable which determine the course of the stars, otherwise than by their effects on the orbits. In both cases it is only a question of economical description, in terms of a smaller number of data than offered by the phenomena under observation. It is not our purpose here to work towards such a theory, except by providing a convenient framework for the collection of data.

9. *Conditioned Choices*

Assume now that we know for each individual who makes a choice i his condition j, which is specified by a set of numbers $j_1, j_2 \ldots$, to be called "data". For instance let i specify the political vote, j_1 the newspaper of the voter, j_2 his income group, j_3 his profession, j_4 his age, etc. There is no need at this point to draw clear distinction between data which are themselves subject to choice, and those on which the individual has no influence.

The distribution of the population is now described by the "qualified preferences" $p(i,j)$. Again we associate utility coefficients U_i with the choices, and define the utility function as†

$$U = \sum_i \sum_j U_i p(i,j). \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

This appears as an extension of equation (6), but is really identical with it, as may be seen if we introduce the summed or "equalized" preferences, obtained by ignoring j or i

$$p(i) = \sum_j p(i,j), \qquad p(j) = \sum_i p(i,j). \quad . \quad . \quad . \quad . \quad (14)$$

Thus

$$U = \sum_i \sum_j U_i p(i,j) = \sum_i U_i \sum_j p(i,j) = \sum_i U_i p(i)$$

which is the same as equation (6).

The freedom function F on the other hand may now be defined as

$$F = -\sum_i \sum_j U_i p(i,j) \log p_j(i), \quad . \quad . \quad . \quad . \quad . \quad (15)$$

where $p_j(i)$ is a "conditional preference"

$$p_j(i) = \frac{p(i,j)}{\sum_i p(i,j)} = \frac{p(i,j)}{p(j)}. \quad . \quad . \quad . \quad . \quad . \quad (16)$$

* The interest of statistical models for social phenomena was emphasized by Reinhold Fuerth in his lecture "Physics of Social Equilibrium" before the British Association, Edinburgh, August 15th, 1951. (*Adv. of Sci.*, 8, 429, 1952.)

Our "social potential" Φ bears a strong resemblance to some of the characteristic functions of thermodynamics, such as the "free energy" or the "Gibbs thermodynamical potential", and equation (9) will remind the physicist of the "canonical distribution" of statistical mechanics. On closer inspection, however, the similarity turns out to be mathematical rather than physical.

† We use the same notations for preferences as Shannon in his Theory of Communication for probabilities.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This is the proportion of individuals in a condition j who elect i. The function F can be considered as Shannon's (1949, p. 22) "conditional entropy"

$$H_j(i) = -\sum_i \sum_j p(i,j) \log p_j(i),$$

weighted with the utility coefficients U_i.

We consider now, as before, the maximum of the social potential $\Phi = U + F$, with the auxiliary condition

$$\sum_i \sum_j p(i,j) = 1. \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Using equation (16) we can write

$$\Phi = U + F = \sum_i \sum_j U_i p(i,j) \; [1 - \log p(i,j) + \log \sum_k p(k,j)]. \quad . \quad . \quad (18)$$

For clarity we have here used the dummy suffix k instead of i under the third summation sign. Differentiating with respect to $p(i,j)$ gives

$$\frac{\partial \Phi}{\partial p(i,j)} = U_i[1 - \log p(i,j) + \log \Sigma\, p(i,j) - 1] + \sum_j U_i \frac{p(i,j)}{\sum_k p(k,j)}$$

$$= - U_i \log p_j(i) + \sum_i U_i p_j(i).$$

The necessary conditions for a maximum of Φ, with the auxiliary condition (17) are now

$$- U_i \log p_j(i) = \Lambda - \sum_i U_i p_j(i). \quad . \quad . \quad . \quad . \quad (19)$$

We have as many equations as there are combinations i, j, hence if the utility coefficients U_i were known, we could solve for the $p_j(i)$.

One solution is immediately evident. Let the conditional preferences be independent of j, i.e., $p_j(i) = p(i)$. In this case the right hand side of equation (19) is a constant, which we can merge into Λ, and the solution is

$$\log p\,(i) = - \Lambda/U_i, \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

which is the same as equation (11). It can be shown that this solution actually represents a maximum of Φ, but the proof will be left for later.

This solution corresponds to complete independence of i and j, because if

$$p_j(i) \equiv \frac{p(i,j)}{p(j)} = p(i),$$

we have also

$$p_i(j) = \frac{p(i,j)}{p(i)} = p(j),$$

and

$$p(i,j) = p(i)p(j). \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

By equation (21) this distribution, which makes Φ a maximum, contains a "canonical" i-factor

$$p(i) = \exp\,(- \Lambda/U_i),$$

where Λ is determined by the condition

$$\Sigma_i e^{-\Lambda/U_i} = 1.$$

The j-factor in $p(i,j)$ remains completely undetermined.

Thus the condition of maximum Φ at given utilities U_i takes us back to the case discussed in the previous section. On the other hand, if now we try to invert the problem, it soon becomes clear that this is not possible, because now we have more equations (20) than available parameters U_i. Hence an actual distribution, which is not of the type $p(i,j) = p(i)p(j)$ cannot be interpreted as corresponding to a maximum of Φ, with equation (17) as only auxiliary condition. It will be shown, however, that it can be interpreted as a smaller *conditional* maximum, with further auxiliary

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

conditions, which correspond to certain hidden constraints. The detailed analysis of these constraints will be given in the next section, here we evaluate first their effect on U, F and Φ.

We now adopt equation (20) as the *definition* of the utility coefficients, i.e., we put

$$U_i = -\Lambda/\log p(i) = -\Lambda/\log \sum_j p(i,j) \quad . \quad . \quad . \quad . \quad (22)$$

and substitute these values of U_i into equations (14) and (17). The aggregate utility now becomes

$$U = -\Lambda \sum_i \sum_j \frac{p(i,j)}{\log p(i)} = -\Lambda \sum_i \frac{p(i)}{\log p(i)} \quad . \quad . \quad . \quad . \quad (23)$$

This is the same as equation (12), i.e., the value obtained by ignoring the conditions j. On the other hand the aggregate freedom is now

$$F = \Lambda \sum_i \sum_j p(i,j) \frac{\log p_j(i)}{\log p(i)}. \quad . \quad . \quad . \quad . \quad . \quad (24)$$

In the sum $\Phi = U + F$ (at given Λ), only F has changed, and it will be shown in a moment that it has become smaller.

We now form, as before, the ratio of freedom to utility, which may be called the *qualified freedom index* $f_{i,j}$

$$f_{i,j} = \frac{F}{U} = \frac{\sum_i \sum_j p(i,j) \log p_j(i)/\log p(i)}{-\sum_i p(i)/\log p(i)}. \quad . \quad . \quad . \quad . \quad . \quad (25)$$

This is the product of the diversity factor, as previously defined in equation (2)

$$D_i = -1/\sum_i \frac{p(i)}{\log p(i)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and of a second factor, which may be called the *factor of independence*

$$I_{i,j} = \sum_i \sum_j p(i,j) \frac{\log p_j(i)}{\log p(i)} = \sum_i \frac{1}{\log p(i)} \sum_j p(i,j) \log \frac{p(i,j)}{p(j)}$$

$$= 1 + \sum_i \sum_j \frac{p(i,j)}{\log p(i)} \log \frac{p(i,j)}{p(i)p(j)}. \quad . \quad (26)$$

It is seen by inspection that this factor is never negative, and that it is unity in the case of independence, i.e., if $p(i,j) = p(i)p(j)$. It will be shown that in all other cases it is smaller than unity. By this we justify the term "factor of independence", and also supply the proof, which we have postponed, that the case of independence represents a maximum of F/U, hence also of Φ.

We prove that the quantity

$$\varepsilon^2_{i,j} \equiv 1 - I_{i,j} = -\sum_i \sum_j \frac{p(i,j)}{\log p(i)} \log \frac{p(i,j)}{p(i)p(j)} \quad . \quad . \quad . \quad (3)$$

is always positive by adding to it the quantity of zero value

$$\sum_i \frac{1}{\log p(i)} \sum_j [p(i,j) - p(i)p(j)] = 0.$$

Thus

$$-\sum_i \sum_j \frac{p(i,j)}{\log p(i)} \log \frac{p(i,j)}{p(i)p(j)} = -\sum_i \sum_j \frac{p(i,j)}{\log p(i)} \left[\log \frac{p(i,j)}{p(i)p(j)} - 1 + \frac{p(i)p(j)}{p(i,j)} \right]. \quad . \quad (27)$$

In this sum no term can be negative, because if we write $p(i,j)/p(i)p(j) = x$, the square bracket assumes the form $\log x - 1 + 1/x$, and this function is never negative for positive x.

Thus, as we have already discussed in the introductory section, the freedom coefficient splits up into two factors which express the two essential features of statistical freedom; diversity and

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

independence. From now on we will operate, instead of with $I_{i,j}$ with the *coefficient of dependence* $\varepsilon_{i,j}$. By representing $1 - I_{i,j}$ as a square we emphasized the fact that it is a positive quantity; we also conform to statistical practice because the coefficients of contingency of Pearson and of Tschuprow (Kendall, 1943) are also square roots of quantities obtained by summation.

Before discussing the mathematical properties of these coefficients, it will be useful to illuminate the process which led to equation (25) from another angle.

10. *The Constraints*

It was mentioned in the previous section that the reduction of F and of Φ by interdependent i and j can be ascribed to certain hidden constraints. We will now follow this interpretation in some detail, assuming the constraint in the simplest mathematical form possible, as an additional auxiliary condition

$$\sum_i \sum_j c_{ij} p(i,j) = \text{const.} \quad . \quad . \quad . \quad . \quad . \quad (28)$$

The "constraint coefficients" c_{ij} can be arranged in a twofold table, but it may be noted that they do not form a matrix, because the i, j can be renumbered independently at will.

We will now interpret the observed distribution $p(i,j)$ as having been produced by maximizing the social potential Φ with the auxiliary conditions (17) and (28). Maximizing the expression

$$\Phi - \Lambda' \sum_i \sum_j p(i,j) - \Lambda'' \sum_i \sum_j c_{ij} p(i,j)$$

with the Lagrangean multipliers Λ' and Λ'' leads to equations

$$- U_i \log p_j(i) + \sum_i U_i p_j(i) - \Lambda' - \Lambda'' c_{ij} = 0. \quad . \quad . \quad (29)$$

Introducing, from equation (20), $U_i = \Lambda/\log p(i)$, and determining Λ' so that all the constraint coefficients vanish if the distribution is independent gives

$$\Lambda' = \Lambda\left[1 - \sum_i \frac{p(i)}{\log\ p(i)}\right],$$

and

$$c_{ij} = \frac{\Lambda}{\Lambda''}\left[\frac{\log p(i,j)/p(i)p(j)}{\log p(i)} - \sum_i \frac{p(i,j) - p(i)p(j)}{p(j) \log p(i)}\right]. \quad . \quad . \quad . \quad (30)$$

These are the constraint coefficients which have brought about the actual distribution, defined only up to a free factor. This could be determined if we knew the sum of constraints, equation (28). Multiplying the equations (30) by $p(i,j)$ and summing over all values gives

$$\sum_i \sum_j c_{ij} p(i,j) = \frac{\Lambda}{\Lambda''} \sum_i \sum_j \frac{p(i,j)}{\log\ p(i)} \log \frac{p(i,j)}{p(i)p(j)} = -\frac{\Lambda}{\Lambda''} \varepsilon^2_{i,j}. \quad . \quad . \quad (31)$$

The second term of equation (30) has vanished in the summation.

Equation (31) shows clearly the relation between constraints and dependence. The sum of constraints is an alternative measure for the squared coefficient of dependence. This suggests normalizing the constraints by putting $-\Lambda/\Lambda'' = 1$, so that the sum of constraints becomes equal to $\varepsilon^2_{i,j}$. We can now interpret the equations 30 as an analysis of the dependence between i and j into its elementary components, in terms of linear constraints. These constraints, together with the utility coefficients are the "forces" in our interpretation of social dynamics. As has been said before, at the present stage this is a theory in the Aristotelian sense only; with as many *ad hoc* forces as there are phenomena. It might become a theory in the Newtonian sense only if practical studies reveal simple laws governing the constraints and utilities.

The considerations which led to equations (30) and (31) are an alternative way of stating the results of the last section. They are of interest because they explain why the method had to give a reduced freedom coefficient in the case of dependence; simply by the fact that a conditional maximum can never be higher than an absolute maximum. It is now seen also that ours is a general method for constructing statistical coefficients of contingency. With certain obvious

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

restrictions, one can start with *any* social potential function Φ and arrive at an equation similar to equation (31). Our measures are not unique, but they are probably the simplest.

It might appear desirable to normalize the utilities, as we have normalized the constraints. This may be of particular interest in the special case of "economic choice", in which the i represent the purchase of goods. It appears natural in this case to normalize the utilities by the convention that the sum of money spent is equal to the aggregate utility acquired. If P_i is the price of the goods i, and s is the sum spent per head of population, we put

$$s = \sum_i P_i p(i) = \sum_i U_i p(i). \quad . \quad . \quad . \quad . \quad . \quad (32)$$

Hence by equation (20)

$$\Lambda = -\frac{\Sigma P_i p(i)}{\Sigma p(i)/\log\ p(i)} = sD_i,$$

and

$$U_i = -sD_i/\log p(i). \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

This defines the utility coefficients in terms of money. It may be again emphasized that these are *statistical* coefficients, and have little in common with what goes by this name in economic theory.

If the convention (32) is adopted, one can say that a shop offers a diversity of D_i units of money for every unit of money spent in it, say 1·58 shillingsworth of choice for a shillingsworth of purchase. This might be a useful measure of the effective variety offered by shops.

11. *Mathematical Properties of the Coefficients of Dependence*

In Section 9 we have derived the coefficient of dependence of a choice i on conditions j

$$\varepsilon^2_{i,\,j} = -\sum_i \sum_j \frac{p(i,j)}{\log p(i)} \log \frac{p(i,j)}{p(i)p(j)}, \quad . \quad . \quad . \quad . \quad (3)$$

and we have shown that it is always between 0 and 1; zero only if there is complete independence, so that $p(i,j) = p(i)p(j)$, in which case every term vanishes. We note now that it is unity only if j determines i completely. This follows from

$$1 - \varepsilon^2_{i,\,j} = \sum_i \sum_j p(i,j) \frac{\log p_j(i)}{\log p(i)} = \sum_i \sum_j \frac{p(j)}{\log p(i)} p_j(i) \log p_j(i). \quad . \quad . \quad (34)$$

It is seen that this can vanish only if for a given j there is only one i for which $p_j(i) = 1$, while for all other i it is zero.

It is evidently irrelevant that we have interpreted i as a choice, j as a condition; $\varepsilon_{i,\,j}$ can be considered as a measure of the influence of any phenomenon j on another phenomenon i. It can be used therefore in all cases in which "coefficients of contingency" are of interest. But unlike the coefficient C of Pearson, and T of Tschuprow, our $\varepsilon_{i,\,j}$ are not reciprocal, i.e., in general

$$\varepsilon_{i,\,j} \neq \varepsilon_{j,\,i}.$$

This may be illustrated in a classical example; in the case of Galton's (1886) contingency table between the eye-colour F_i of fathers, and of their eldest sons, E_j.

TABLE 3

Galton's Contingency Table of the Incidence of Eye-Colour, in a Group of Fathers and Eldest Sons. Fathers i, *Sons* j.

i \ j	1	2	3	4	$p(i)$
1	0·194	0·083	0·025	0·056	0·358
2	0·070	0·124	0·034	0·036	0·264
3	0·041	0·041	0·055	0·043	0·180
4	0·030	0·036	0·023	0·109	0·198
$p(j)$	0·335	0·284	0·137	0·244	1·000

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

From this table Pearson's mean square contingency is found to be

$$\Phi^2 = \sum_i \sum_j \frac{[p(i,j) - p(i)p(j)]^2}{p(i)p(j)} = 0{\cdot}266.$$

Pearson's coefficient of mean square contingency is

$$C^2 = \Phi^2/(1 + \Phi^2) = 0{\cdot}21, \qquad C = 0{\cdot}46$$

while Tschuprow's coefficient of contingency is

$$T = \Phi/(n-1)^{\frac{1}{2}}(m-1)^{\frac{1}{2}} = 0{\cdot}30,$$

where n, m are the numbers of rows and columns in the table. Our coefficients of dependence are

$$\varepsilon^2_{,i\,j} = 0{\cdot}0922 \qquad \varepsilon_{i,\,j} = 0{\cdot}304$$
$$\varepsilon^2_{j,\,i} = 0{\cdot}0800 \qquad \varepsilon_{j,\,i} = 0{\cdot}283$$

This means that given the eye colour of the father one can infer the eye colour of the son with less certainty than conversely.

While $\varepsilon_{i,\,j}$ is unity only if j uniquely determines i, $\varepsilon_{j,\,i}$ is unity only if j is uniquely given by i. Both will be unity only if there is a one-to-one correspondence between i and j. Hence one could consider

$$\varepsilon^2 = \tfrac{1}{2}(\varepsilon^2_{i,\,j} + \varepsilon^2_{j,\,i}) \quad . \quad . \quad . \quad . \quad . \quad . \quad (35)$$

as a "*coefficient of interdependence*".

The most important property of the coefficients of dependence, mentioned in Section 3, is this: *the coefficient of dependence will never decrease if a new factor, previously ignored in the analysis, is taken into consideration.*

Elsewhere we have denoted factors by $j_1, j_2, \ldots$, but now, to save suffixes let j stand for all the factors previously considered, and k for the new factor, previously ignored. We can write the squared coefficient of dependence, with k ignored, in the form of a triple sum

$$\varepsilon^2_{i,\,j} = -\sum_i \sum_j \frac{p(i,j)}{\log p(i)} \log \frac{p(i,j)}{p(i)p(j)} = -\sum_i \sum_j \sum_k \frac{p(i,j\,k)}{\log p(i)} \log \frac{p(i\,j)}{p(i)p(j)}.$$

Taking k into account, this becomes

$$\varepsilon^2_{i,\,jk} = -\sum_i \sum_j \sum_k \frac{p(i,j\,k)}{\log p(i)} \log \frac{p(i,j\,k)}{p(i)p(j,k)}.$$

The increase is

$$\varepsilon^2_{i,\,jk} - \varepsilon^2_{i,\,j} = -\sum_i \sum_j \sum_k \frac{p(i,j\,k)}{\log p(i)} \log \frac{p(i,j\,k)p(j)}{p(i,j)p(j,k)}. \quad . \quad . \quad . \quad (36)$$

Adding to this the expression of zero value

$$\sum_i \sum_j \sum_k \frac{1}{\log p(i)} \left[p(i,j,k) - \frac{p(i,j)p(j,k)}{p(j)} \right] = 0,$$

the increase appears in the form

$$\varepsilon^2_{i,\,jk} - \varepsilon^2_{i,\,j} = -\sum_i \sum_j \sum_k \frac{p(i,j,k)}{\log p(i)} \left[\log \frac{p(i,j\,k)p(j)}{p(i,j)p(j,k)} - 1 + \frac{p(i,j)p(j,k)}{p(i,j\,k)p(j)} \right]. \quad . \quad (37)$$

This proves the statement, because the brackets are of the form

$$\log x - 1 + 1/x$$

which is never negative for x positive.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The increase is zero if and only if

$$p(i, j\,k)p(j) = p(i, j)p(j, k). \quad . \quad . \quad . \quad . \quad . \quad (38)$$

Let $p_j(i)$ be the conditional preference of i at given j, $p_{jk}(i)$ at given j and k. As

$$p(i, j\,k) = p(j, k)p_{jk}(i), \qquad p(i, j) = p(j)p_j(i),$$

equation (38) is equivalent with

$$p_{jk}(i) = p_j(i). \quad . \quad . \quad . \quad . \quad . \quad . \quad (39)$$

This means that the specification of the factor k does not influence the conditional preferences. In other words, k has no influence whatever on the phenomenon i. In all other cases addition of a new factor ("qualification"), always increases the dependence.

The trivariate coefficient $\varepsilon_{i,\,jk}$ cannot be inferred from the bivariate coefficients $\varepsilon_{i,\,j}$, $\varepsilon_{i,\,k}$, and $\varepsilon_{j,\,k}$, but there exists an interesting inequality if k, j are independent of one another, so that

$$\varepsilon_{j,\,k} = \varepsilon_{k,\,j} = 0. \quad . \quad . \quad . \quad . \quad . \quad . \quad (40)$$

In this case it can be shown that *the squared coefficient of dependence on the factors* j, k *taken jointly is never less than the sum of the squared dependence coefficients on the factors taken singly.* I.e., for two factors independent of one another by equation (40)

$$\varepsilon^2_{i,\,jk} \geqslant \varepsilon^2_{i,\,j} + \varepsilon^2_{i,\,k}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (41)$$

To prove this we form

$$\varepsilon^2_{i,\,jk} - (\varepsilon^2_{i,\,j} + \varepsilon^2_{i,\,k}) = -\sum_i \sum_j \sum_k \frac{p(i, j\,k)}{\log p(i)} \log \frac{p(i)p(j)p(k)p(i, j\,k)}{p(i, j)p(i, k)p(j, k)}.$$

We add to this and subtract the expression

$$S = \sum_i \frac{1}{\log p(i)} \sum_j \sum_k \left[p(i, j, k) - \frac{p(i, j)p(i, k)p(j, k)}{p(i)p(j)p(k)} \right]$$

$$= \sum_i \frac{p(i)}{\log p(i)} \left[1 - \sum_j \sum_k p_i(j)p_i(k) \frac{p(j, k)}{p(j)p(k)} \right].$$

This gives

$$\varepsilon^2_{i,\,jk} - (\varepsilon^2_{i,\,j} + \varepsilon^2_{i,\,k}) = -\sum_i \sum_j \sum_k \frac{p(i, j\,k)}{\log p(i)} [\log x - 1 + 1/x] - S, \quad . \quad (42)$$

where

$$x = \frac{p(i)p(j)p(k)p(i, j\,k)}{p(i, j)p(i, k)p(j, k)}. \quad . \quad . \quad . \quad . \quad . \quad (43)$$

Hence the first term in equation (42) is never negative. As for j, k independent, that is for

$$p(j, k) = p(j)p(k)$$

the expression S vanishes, the statement, expressed in equation (41), is proved.

One can express this result by saying that variates independent of one another have a *positive interaction* in their effect on a third variate i unless $x = 1$, in which case

$$p_i(j, k) = p_i(j)p_i(k). \quad . \quad . \quad . \quad . \quad . \quad . \quad (44)$$

That is to say the interaction is zero only if the variates j, k are independent *for every* i.

In the example of choice of profession, discussed in the first part, the varites j_1 and j_2 were not quite independent of one another, because we had $\varepsilon^2_{j_1,\,j_2} = 0{\cdot}03112$. Yet the interaction was positive, because we had $\varepsilon^2_{i,\,j_1} = 0{\cdot}24669$, and $\varepsilon^2_{i,\,j_2} = 0{\cdot}11548$, whose sum is $0{\cdot}36217$, while the trivariate coefficient of dependence was $\varepsilon^2_{i,\,j_1 j_2} = 0{\cdot}38845$, somewhat larger. In the case of strongly interdependent factors the interaction can become negative. This must be the case for instance if the factors are completely interdependent and represent really only one factor, so that $\varepsilon_{i,\,j} = \varepsilon_{i,\,k} = \varepsilon_{i,\,jk}$.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It has been mentioned in Section 4, that, as $\varepsilon^2_{i,j}$ is a sum over all cases i,j, it is possible to allocate to each group i,j a share in the total dependence. This allocation is of course to some extent arbitrary, because we can always add to $\varepsilon^2_{i,j}$ an expression of zero value which changes the distribution without changing the sum. In Section 10 we have carried out an allocation in terms of linear constraint coefficients,

$$\varepsilon^2_{i,j} = \sum_i \sum_j c_{ij} p(i,j). \quad . \quad . \quad . \quad . \quad . \quad . \quad (45)$$

It may be of interest to divide up $\varepsilon^2_{i,j}$ in terms of the conditions j only, as these can be considered as the causes of dependence. We can do this directly, by using $p(i,j) = p(j)p_j(i)$ and writing the sum (45)

$$\varepsilon^2_{i,j} = \sum_i \sum_j c_{ij} p(i,j) = \sum_j p(j) \sum_i c_{ij} p_j(i) = \overline{\varepsilon^2_i(j)}, \quad . \quad . \quad . \quad (46)$$

where, using equation (30),

$$\varepsilon^2_i(j) = \sum_i c_{ij} p_j(i) = -\sum_i \frac{p_j(i)}{\log p(i)} \left[\log \frac{p_j(i)}{p(i)} - 1 + \frac{p(i)}{p_j(i)} \right]. \quad . \quad . \quad (47)$$

The $\varepsilon^2_i(j)$ can be considered as "*influence coefficients*" as they represent the reduction of independence per unit population in the condition j. It is seen that they are never negative. As the sum of the $p(j)$ is unity, we can also interpret, as in equation (46), the resulting coefficient of dependence as the mean influence coefficient, averaged over the conditions j.

An example of the allocation of a share in the dependence to different population groups by this method was discussed in Section 4, in the problem of choice of profession. As further examples, one could take the influence of newspapers on the political vote, j being the newspaper, i the vote, or the influence of advertisements on the purchase of goods, j being the group of those who have seen the advertisement. But it must be noted that the influence coefficient is always positive unless j had no influence whatever, so that it might turn out large even if the advertisement had an effect opposite to that intended. In most cases however it will be possible to label the influence "desirable" or "undesirable" by inspection.

12. *Correcting the Diversity Factor by the Method of Secondary Choices*

We describe here a method of purifying raw statistical material, with the aim of meeting an objection, mentioned in Section 5, which can be raised against the definition of the diversity factor. This is, that the formula for D_i does not distinguish between choices which appear essentially distinct to the individuals, and those which are so alike that the population will distribute itself over them more or less evenly out of mere indifference. Moreover, the formula tends to give a high rating to choices of this illusory type.

We propose to meet this objection not by modifying the formula, but by subjecting the preferences to a process of purification based on *secondary choices*. Assume that we know how the population would have distributed itself if any one of the choices i had been unobtainable. Let s_{ik} be the (relative) number of those who would have chosen i but if it is unobtainable choose k instead. The number of those who will rather abstain than choose any other alternative may be represented by s_{ii}. The secondary choices can be arranged in a matrix

i \ k	1	2	3	. . .	n
1	s_{11}	s_{12}	s_{13}	. . .	s_{1n}
2	s_{21}	s_{22}	s_{23}	. . .	s_{2n}
.	. . . . .	. . . . .	. . . . .	. . .	.
n	s_{n1}	s_{n2}	s_{n3}	. . .	s_{nn}

We make the convention that the $p(i)$ form a decreasing sequence, that is to say the choices are numbered in order of popularity. If some of the $p(i)$ are equal, but the corresponding s_{ii} are not, we let the choice with the larger s_{ii} take the precedence.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In principle the matrix can be obtained from n experiments, in each of which one of the choices $i = 1 \ldots n$ is suppressed in turn. In rather exceptional cases this may be obtained by observation. One could for instance observe a newspaper stand, before and after a certain paper is exhausted, assuming of course that normally the supply of papers is sufficient, so that the customers of a certain paper are not in the habit of coming earlier. In most cases it will be easier to obtain the figures by questioning the population, but it is well known that data obtained in this way have not the same degree of reliability as those based on actual choices.

We convert the matrix of the s_{ik} into a diagonal matrix, by certain manipulations based on the following plausible conventions:

1. The fractions s_{ii} who abstain rather than adopt a secondary choice we consider as inseparably belonging to i.

2. If we find a group of m choices, such that the fractions $p(i)$ of those who elect them are equal, and if any one of the choices i is cancelled its customers will distribute themselves evenly over the remaining $m - 1$ choices, we consider this group as representing only *one* choice. We can indeed interpret the behaviour of the population as one of absolute indifference.

3. If there are two choices, i and k and $s_{ik} \neq s_{ki}$ of which let, say, s_{ik} be the smaller one, we consider the two choices as one as far as the fraction $2s_{ik}$ of the population is concerned, because this is the number of those willing to change places if their favourite choice is cancelled. Similarly if there is a group of m choices, we consider this group as one choice with respect of $m(m-1)$ times the smallest of the numbers s_{ik}, $(i \neq k)$, in the group, because it is this fraction which displays complete indifference.

These conventions are not sufficient in themselves to give a unique rule of manipulation, and will be supplemented by two others:

4. We consider the indifferent part $m(m-1)s_{ik}$ of the group m as if it had voted for the most popular choice in the group, that is the one with the largest $p(i)$ (which is by our convention of numbering the choices the one with the smallest i), and add it to s_{ii}.

5. If a pair s_{ik}, s_{ki} belong to more than one group, we make the convention that we consider it as belonging to the group which contains the largest $p(i)$, i.e., the smallest i.

These conventions are sufficient for determining the "sweeping" operations, which, repeatedly applied, gradually clear the matrix of all non-diagonal terms, so that in the end only diagonal terms are left, whose sum is unity. These operations may now be explained in a numerical example. Let the matrix of secondary choices be, in percentages:

i \ k	1	2	3	4	5	6	7	8	$p(i)$
1	5	10	8	1	1	0	0	0	25
2	8	4	5	2	1	0	0	0	20
3	6	4	3	2	1	0	0	0	16
4	3	2	2	2	2	1	0	0	12
5	2	2	1	1	1	1	1	0	9
6	1	1	1	2	1	1	0	0	7
7	1	0	0	0	2	1	1	1	6
8	0	0	0	1	1	1	2	0	5
									100

First we divide this matrix into "groups". A "compact" group is a set of matrix terms, in which none of the non-diagonal terms is zero, and which fill a square in the matrix, with two corners on the main diagonal. It can be seen by inspection that there are three compact groups in this matrix: one 5×5, one 3×3 and one 2×2. The matrix could also contain groups which

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

would become compact by suitable renumbering of i, k, that is to say by equal transpositions of rows and columns. We make the simplifying convention that we do not undertake such a renumbering, except if the previously given rule is not sufficient for a unique ordering of the i, i.e., if $p(i)$ and s_{ii} are both the same for more than one i. In this case we make the convention that the process to be described is to be carried out for all permutations of the i whose order is doubtful, until the smallest diversity factor is reached.

In the present example all the $p(i)$ are different, hence only the compact groups need be considered. Two of these overlap in two terms, s_{45} and s_{54}, hence an order must be fixed for the sweeping of the groups. We make the convention that we start with the group farthest to the left, and proceed to the right. By this we ensure that the terms which are shared by several groups are added to the more popular choice. The first two sweeping operations give the modified matrices:

25	9	7	0	0	0	0	0
7	4	4	1	0	0	0	0
5	3	3	1	0	0	0	0
2	1	1	2	1	1	0	0
1	1	0	0	1	1	1	0
1	1	1	2	1	1	0	0
1	0	0	0	2	1	3	0
0	0	0	1	1	1	1	0

after first sweep,

43	6	4	0	0	0	0	0
4	4	1	1	0	0	0	0
2	0	3	1	0	0	0	0
2	1	1	2	1	1	0	0
1	1	0	0	3	0	1	0
1	1	1	2	0	1	0	0
1	0	0	0	2	1	3	0
0	0	0	1	1	1	1	0

after second sweep.

After the first sweep there is one 3×3 compact group left, and one 2×2. After the second sweep only 2×2 groups are left, of which two are compact. In addition, there are several non-compact groups of $m = 2$ left. Such a group exists wherever s_{ik} and s_{ki} are both different from zero. All these groups can now be swept in one operation, by applying the same rule. Let $i < k$, and, say, $s_{ik} < s_{ki}$. We add $2s_{ik}$ to s_{ii}, and are now left with terms $s_{ki} - s_{ik}$ which have no transpose. We add this residue to s_{kk}, and are now left only with diagonal terms, which represent the purified distribution. In the present example

	i	1	2	3	4	5	6	7	8	
Original distribution . .	$p(i)$	25	20	16	12	9	7	6	5	per cent.
Purified distribution . .	$P(i)$	55	8	8	6	8	5	6	4	,,

While the diversity factor D_i of the original distribution was 2·61 duals, in the purified distribution this is reduced to 1·33 duals.

The method of sweeping can be summed up in the following practical rules:

(1) Starting from left top corner, mark out compact groups. (Parts of these may overlap.) Subtract $(s_{ik})_{min}$ from all non-diagonal terms of the group farthest to the left, and add $m(m-1)$ $(s_{ik})_{min}$ to the leftmost diagonal term of the group.

(2) Repeat the operation for the next group. Carry on from group to group, passing from left to right.

(3) Repeat (1) and (2) until no further compact groups can be formed.

(4) Inspect each term in the upper non-diagonal part of the matrix and its transpose. If the transpose is not zero, subtract the smaller from the larger and sweep $2(s_{ik})_{min}$ horizontally into the diagonal, i.e., into the s_{ii} which is in the same row as the term in the upper part. If the transpose is zero, sweep the term in the upper part vertically downwards into the diagonal. When these operations are completed, the upper part will contain zero terms only.

(5) Sweep all remaining non-zero terms in the lower non-diagonal part horizontally into the diagonal.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

13. *Variation of the Diversity Factor with Statistical Grouping*

The importance of the stability of the measures of freedom against arbitrary grouping of the statistical material was emphasized in Part I. In the case of discrete choices, which are elementary in the sense that they cannot be subdivided, the lumping process explained in the last section may be used for producing a "purified" diversity coefficient, which is proof against the objections which one might raise against excessively detailed choices. If on the other hand the choices can be indefinitely subdivided, in particular if they can be specified by a variable x capable of assuming any value between certain limits, it is preferable to use one of two modified measures. The first of these is the *normalized* diversity

$$\delta_x = \frac{D_1}{\log n} = -\frac{1}{\log n}\,\frac{1}{\sum_1^n \frac{p(i)}{\log p(i)}}, \quad . \quad . \quad . \quad . \quad . \quad (48)$$

and the second is the diversity factor D_x for choices specified by a variable x

$$D_x = -1\Big/\int \frac{P(x)dx}{\log P(x)}, \qquad \left(\int P(x)dx = 1\right) \quad . \quad . \quad . \quad (5)$$

As we are dealing with populations consisting of individuals, $P(x)$ cannot be considered as a continuous function, but is defined as follows: let $x_o, x_1, \ldots x_i, \ldots x_n$ be the intervals into which we divide the range of x, and let $p(i)_n$ be the fraction of individuals in the ith interval. We had to add the suffix n to $p(i)$, as n, which stands for the method of subdivision must now be considered as variable. Then

$$P[\tfrac{1}{2}(x_{i-1} + x_i)] = \lim p(i)_n/(x_i - x_{i-1}). \quad . \quad . \quad . \quad . \quad (49)$$

Thus $P(x)$ is defined at n points only. The limit is not pushed to zero, but only down to intervals which still contain a not too small number of individuals. This is the usual condition whenever discrete distributions are approached by smooth functions. In our case there is also a second condition: in order to exclude safely the case $P = 1$, the smallest interval must still be of at least unit length. With these reservations we interpret the integral in equation (5) as follows

$$\int_{x_o}^{x_n} \frac{P(x)dx}{\log P(x)} = \lim \sum_1^n \frac{p(i)_n}{\log \frac{p(i)_n}{(x_i - x_{i-1})}}, \qquad \sum_1^n p(i)_n = 1. \quad . \quad . \quad (50)$$

In the special case where the interval $x_n - x_o = X$ is evenly subdivided into n intervals $\Delta x = X/n$

$$1/D_x(n) = -\lim \sum_1^n \frac{p(i)_n}{\log (np(i)_n/X)}. \quad . \quad . \quad . \quad . \quad (51)$$

As we are dealing here with quantities which are defined only to certain limits, quite apart from the fiduciary limits which may be assigned to them to account for the fluctuations of sampling, we suggest that every time the value $D_x(n)$ is stated for a certain n, the value for a division half as fine, i.e., for $\frac{1}{2}n$ be also stated, and preferably also the value for a division twice as detailed, with $2n$ intervals.

A general discussion of the definition limits would be too lengthy, we give instead an illustration. In this example 16 random numbers x were drawn between 0 and 100, and to each x another random number R was associated, also between 0 and 100. This gave the distribution shown in the table below, and illustrated in Fig. 3.

From the table the diversity coefficients $\delta_i(n)$ and $D_x(n)$ were computed for $n = 2, 4, 8, 16, 32$ and 64 equal divisions of the range $X = 100$, giving the table which is illustrated in Fig. 4.

It is seen, as must be expected, that both coefficients fall off rather rapidly when n exceeds the sample size, which is $N = 16$. Yet, even in this somewhat crude example, with a far too small sample size, we find that near $n = 8$ both coefficients are defined to fairly close limits, because between $n = 4$ and $n = 8$, δ_i varies only by 2·60 per cent., and D_x by 2·85 per cent.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

x	R	$r = R/\Sigma R$
5	59	·0753
6	41	·0524
11	55	·0702
15	24	·0306
24	85	·1086
32	63	·0805
33	17	·0217
38	93	·1188
44	78	·0996
46	26	·0332
57	36	·0460
62	89	·1137
66	16	·0204
77	47	·0600
87	17	·0217
90	37	·0473
$\Sigma =$	783	1·0000

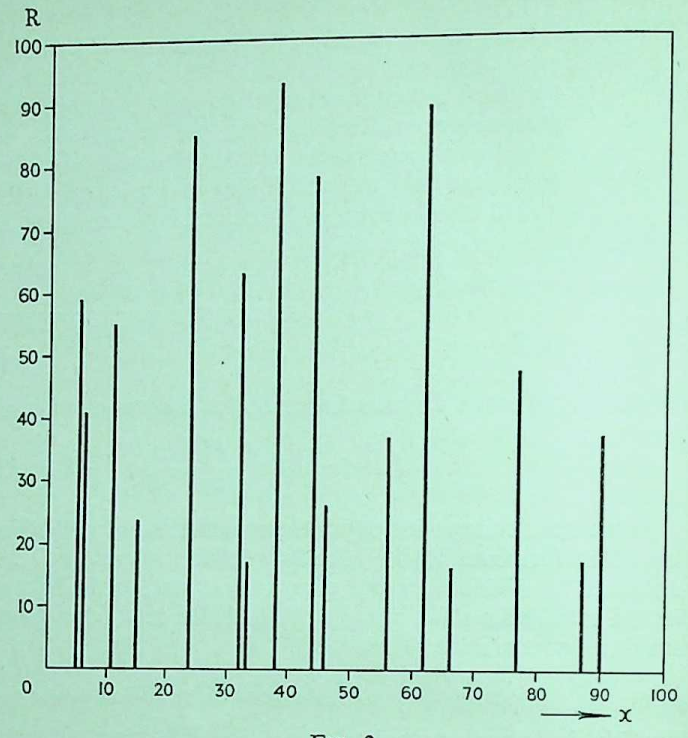


FIG. 3.

n	$\delta_i(n)$	$D_x(n)$
2	·67665	6·49474
4	·88120	6·48763
8	·85829	6·30287
16	·80638	5·91638
32	·67499	5·04914
64	·59017	4·20152

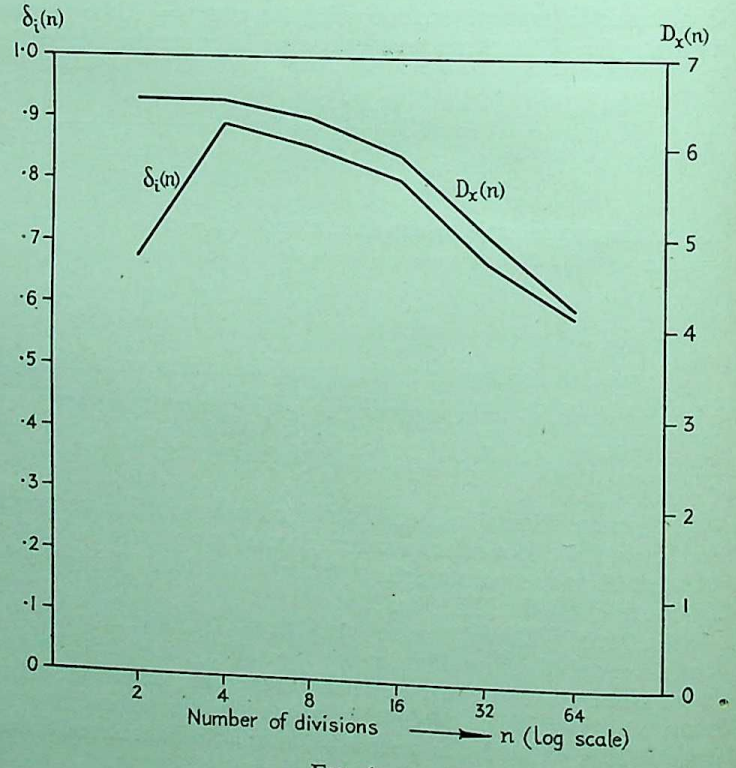


FIG. 4.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

14. *Variation of the Coefficient of Dependence with Statistical Grouping**

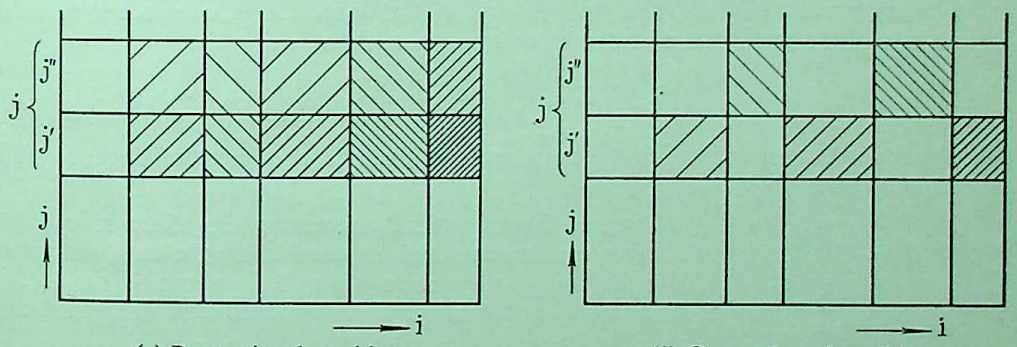
The behaviour of the coefficients of dependence with subdivision is summed up in the two propositions:

1. *The coefficients of dependence are never decreased by a finer subdivision of the factors, and approach an upper limit.*

2. *Within finer subdivision of the choices the coefficients of dependence may increase at first, but they decrease if the subdivision is pushed so far as to reveal indifference to the finer distinctions. There exists therefore a certain subdivision which reveals the largest or maximum dependence.*

It is understood that a "finer subdivision" is one which comprises the previous subdivision; not one which cuts across it. As explained in Part I, these two properties must be postulated for any statistical coefficient which deserves the name of "coefficient of dependence". They are also practically useful properties, as they suggest that this coefficient should be calculated with as fine a subdivision of factors as available, and with that grouping of the choices which gives the largest dependence. One can then repeat the computation with a division of the factors half as fine, and with divisions of the choices off the optimum, in order to estimate the limits in which the coefficient can be considered as defined.

The proposition 1 is easily proved, as it can be reduced to our previous result that "qualification", that is to say the taking into account of a new factor, previously ignored, never decreases the dependence. If all previous statistical groups are divided into two, we can represent this by a new factor, say j_2, which has only two values, say 1 and 2. Let "1" mean that in every previous group of j_1 the first subgroup is taken, and let "2" mean the second subgroup. But we can equally well represent by a new factor of this type the case in which only one, or any number smaller than the total of the groups j_1 is subdivided; all we have to do is to stipulate that the new factor is operative only for the specified groups of j_1.



(*a*) Proportional partition. (*b*) Chequerboard partition.

FIG. 5.—Illustrating the subdivision of factors.

In order to visualise the first proposition, in Figs. 5*a* and 5*b* the groups i, j are shown as "cells", and the preferences $p(i, j)$ are indicated by density of shading. Consider the case of one datum j divided into two, j' and j''. The increase in the coefficient of dependence due to this splitting of a row is expressed by the formula

$$\varepsilon^2_{i,\,j'\,j''} - \varepsilon^2_{i,\,j} = -\sum_i \frac{1}{\log p(i)} \left\{ p(i,j') \log \frac{p(i,j')}{\sum_i p(i,j')} + p(i,j'') \log \frac{p(i,j'')}{\sum_i p(i,j'')} - [p(i,j') + p(i,j'')] \log \frac{p(i,j') + p(i,j'')}{\sum_i [p(i,j') + p(i,j'')]} \right\} . \quad (52)$$

By proposition 1 this is never negative.

* Parts of this section have been amended in the light of Prof. Champernowne's contribution to the discussion.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It can be seen immediately that if in the rows j', j'' we find the preferences in the same ratios as in the original row j, in other words if

$$p(i,j') = x\,p(i,j), \qquad p(i,j'') = (1-x)p(i,j''),$$

where x is any number between 0 and 1, the expression (52) is zero. This is as it must be, because in this case the subdivision has not revealed any further details. This case of "proportional partition" is illustrated in Fig. 5*a*.

On the other hand if we find markedly different dependences on i in the two rows, the expression (52) will be positive. A simple case of this is the "chequerboard" pattern, shown in Fig. 5*b*. For simplicity let us number the i for which $p(i,j') = p(i,j)$ and $p(i,j'') = 0$ from 1 to m, and the others from $m+1$ to n. Substitution into equation (52) gives

$$\varepsilon^2_{i,\,j'\,j''} - \varepsilon^2_{i,\,j} =$$

$$\log\left[\sum_1^m p(i,j)/\sum_1^n p(i,j)\right]\sum_1^m \frac{p(i,j)}{\log p(i)} + \log\left[\sum_{m+1}^n p(i,j)/\sum_1^n p(i,j)\right]\sum_{m+1}^n \frac{p(i,j)}{\log p(i)}$$

$$= \log\sum_1^m p(i,j)\sum_1^m \frac{p(i,j)}{\log p(i)} + \log\sum_{m+1}^n p(i,j)\sum_{m+1}^n \frac{p(i,j)}{\log p(i)} - \log\sum_1^n p(i,j)\sum_1^n \frac{p(i,j)}{\log p(i)}. \quad . \quad . \quad (53)$$

This is written in two forms. The first form shows that it is always positive. The second form shows that it must have a largest value at a distribution at which neither of the rows j', j'' is empty. The last term is independent of the partition, and from the symmetry of the first two terms it is evident that the largest value is obtained if these terms are as nearly equal as possible. If they are equal one obtains, as an upper limit, the value

$$\log\tfrac{1}{2}\sum_i \frac{p(i,j)}{\log p(i)}.$$

This is the largest possible effect of the splitting of row j. Splitting all rows, one finds by summation that the increase of the coefficient of dependence is not more than

$$\log\tfrac{1}{2}\sum_i \frac{p(i)}{\log p(i)} = -\frac{\log\frac{1}{2}}{D_i}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (54)$$

Another upper limit is of course set by the condition that the coefficient of dependence after partition cannot exceed unity.

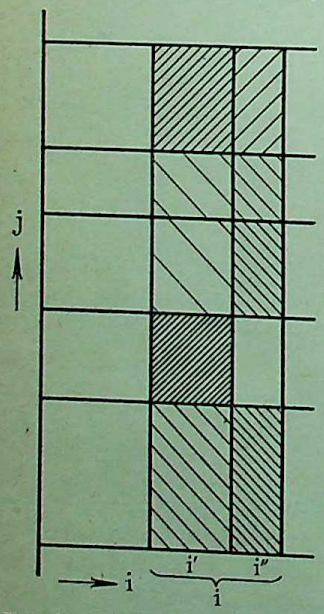


FIG. 6.—Subdivision of choices.

The second proposition, concerning the effect of subdivision of choices can be discussed by considering the case, illustrated in Fig. 6, in which one choice i is split into two, i' and i''. The splitting of this column increases the coefficient of dependence by

$$\varepsilon^2_{i'\,i'',\,j} - \varepsilon^2_{i,\,j} =$$

$$-\sum_j\left\{\frac{p(i',j)}{\log\sum_j p(i',j)}\log\frac{p(i',j)}{p(j)} + \frac{p(i'',j)}{\log\sum_j p(i'',j)}\log\frac{p(i'',j)}{p(j)}\right.$$

$$\left.-\frac{p(i',j)+p(i'',j)}{\log\sum p(i',j)+p(i'',j)}\log\frac{p(i',j)+p(i'',j)}{p(j)}\right\}. \quad . \quad . \quad (55)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It may be seen by inspection that this is zero if either one or the other of the two columns i' or i'' is empty, and it is easy to show that it is never negative for any "chequerboard partition" in which one of the two cells is empty for every j. On the other hand, it is negative for "proportional partition"

$$p(i',j) = x\,p(i,j) \qquad p(i'',j) = (1-x)p(i,j),$$

except if x is zero or unity. This can be understood, because the constant partition ratio x, independent of j, shows that j has no influence on the partition, hence the subdivision has revealed a certain amount of independence. One finds, by arguments similar to those used before, that the maximum decrease of the coefficient of dependence occurs at equal partition, at $x = \frac{1}{2}$, and in this case

$$-(\varepsilon^2_{i'\,i'',\,j} - \varepsilon^2_{i,\,j})_{max} = -\frac{\log \frac{1}{2}}{\log \frac{1}{2}\,p(i)}\,\frac{1}{\log p(i)}\,\sum_j p(i,j)\log\frac{p(i,j)}{p(i)p(j)}. \qquad (56)$$

This is $(\log \frac{1}{2})/\log \frac{1}{2}p(i)$ times the contribution of the column i to the coefficient of dependence. Hence if we go on subdividing the choices, and from a certain stage onwards no further details are revealed, the coefficient of dependence will still keep decreasing, and the proportional reduction will be of the order $(\log \frac{1}{2})/(\log n)$ if a subdivision with n groups is halved again.

We see here again, as in the case of the diversity factor, that if there is no natural limit to the subdivision, we must either fix a limit by convention, or modify the definition. Otherwise the coefficient of dependence can fall below any limit, because the indifference of the fine detail in the distribution to the conditions j will ultimately outweigh the influence which it has on the coarse features of the distribution.

Thus, if the discrete variate i has to be replaced by a variable x, we modify the definition of the coefficient of dependence to

$$\varepsilon^2_{x,\,j} = \int \frac{dx}{\log P(x)}\,\sum P(x,j)\log\frac{P(x,j)}{P(x)p(j)}, \qquad (57)$$

with

$$P(x) = \sum_j P(x,j), \qquad p(j) = \int P(x,j)dx,$$

and with the conditions

$$\int \sum_j P(x,j)dx = 1, \qquad P(x,j),\ P(x),\ p(j) < 1.$$

If j is also replaced by a variable y, this is further modified to

$$\varepsilon^2_{x,\,y} = \int \frac{dx}{\log P(x)} \int P(x,y)\log\frac{P(x,y)}{P(x)P(y)}\,dy, \qquad (58)$$

with

$$P(x) = \int P(x,y)dy, \qquad P(y) = \int P(x,y)dx,$$

and with the conditions

$$\int\int P(x,y)dxdy = 1, \qquad P(x,y),\ P(x),\ P(y) < 1.$$

The integrations are always carried out over the complete range of x, y; the limits of x must not be dependent on y and vice versa. It is of course understood that the integrals are only shorthand signs for the sums of the same type as introduced in the last section.

It is easy to prove, by the same methods as used in Section 11, that these coefficients of dependence have the same properties as those previously defined for discrete variates, in particular that their values are always between zero and unity. It can also be shown that they possess the same insensitiveness to subdivision between certain rather wide limits as discussed in the case of the diversity factor. The propositions 1 and 2 of this Section also apply to them, but with the important difference that it is now not necessary to set any limit, arbitrary or conventional, to the subdivision of the choices.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

References

BEVERIDGE, SIR WILLIAM (1944), *Full Employment in a Free Society—A Summary*. London: New Statesman & Reynolds News.
CRANSTON, M. (1953), *Freedom—A New Analysis*. London: Longmans, Green & Co.
FOSDICK, D. (1939), *What is Liberty? A Study in Political Theory*. New York: Harper & Bros.
GALTON, F. (1886), "Family Likeness in Eye Colour", *Proc. Roy. Soc.*, **40**, 402.
KENDALL, M. G. (1943), *The Advanced Theory of Statistics*, Vol. I. London: Charles Griffin & Co.
KOLMOGOROFF, A. (1942), "Interpolation und Extrapolation von stationären zufälligen Folgen", *Bull. Ac. Sci. U.S.S.R. ser. math.*, **5**, 3–14.
MONTESQUIEU, C. L. (1914), *The Spirit of the Laws*, Vol. I, 160. London: G. Bell & Sons.
SHANNON, C. E., & WEAVER, W. (1949), *The Mathematical Theory of Communication*. Urbana: University of Illinois Press.
WIENER, N. (1949), *The Extrapolation, Interpolation and Smoothing of Stationary Time Series*. New York: John Wiley.

DISCUSSION ON THE PAPER BY D. AND A. GABOR

Professor BARNARD, proposing a vote of thanks, said: My first reaction to this paper is admiration for the courage of the authors in being prepared to make a first attempt—I think this is the first attempt—at mathematical and statistical treatment of a complicated and highly emotional subject like freedom, and in being prepared to face the inevitable storm of criticism which their paper will provoke.

Before coming to my own contribution of hail and sleet I should like to erect a shelter on one side of the authors' position by saying that I should probably disagree fundamentally with their attitude to freedom, even taking into account the reservations that they make in section 7. I feel that there is something essentially subjective in the idea of freedom, even in the modest sort of freedom involved in the choice of dress, and a treatment which sets out to be objective and statistical is not merely doomed to be limited, it is doomed to failure. In my own thinking on the subject of freedom I have been guided by two texts from rather dissimilar authors, Hegel and Edmund Burke. Hegel said that freedom is knowledge of necessity and that I think contains an essential truth so far as individual freedom is concerned. For political freedom with social applications with which we are more directly concerned, Burke, I think, is more useful, in spite of the detestation I have for the views he came to hold late in life. He had hold on a profound truth when he said "That nation is free that thinks itself so." Both these texts agree in emphasizing a subjective element in freedom and that, I think, is the root of my fundamental disagreement.

I would not wish to pursue this particular point further because we might find ourselves involved in a mere dispute as to words. Whether the authors are entitled to call the concept they have defined freedom or whether it would have been better to have gone to the Greek and invented a word for it—*eleutheria* might be suitable—is largely a matter of taste, but it is not uncommon nowadays to use ordinary words like "information" in a technical sense remote from their ordinary meaning; I have done it myself and must not quarrel with it. We should accept the authors' use of the word and ask ourselves what properties the concept they have defined possesses, what are its varieties and what its virtues and limitations. Perhaps its principal virtue is that it is objective, it calls for nothing more complicated in principle than the sort of work that the Social Survey does every day. It requires the compilation of trivariate tables, as the authors note. Most of us would agree that the publication of more tables on this would be useful, although I would recommend to Dr. Gabor's electrical ingenuity the problem of publishing such tables in a manageable form.

The authors seem to have circumvented the mathematical difficulties in the idea of continuous choice, but there are two difficulties they have not met. They put all their choice on an equal footing. Most would agree that freedom of choice of occupation is more important than freedom of choice of a hat, but because their coefficients are numerical and qualitative, not quantitative, they ignore the nature of the choice involved. Imaginary Table 1 could just as well refer to the son's choice of a hat as to his choice of profession; No. 1 might be a narrow bowler, No. 2 a Homburg, No. 3 no hat at all, and No. 4 a Trilby. One might feel inclined to alter the order. The freedom would then be a freedom of choice of hats and we have to ask ourselves is there any useful sense in which 1·034 duals of freedom in choice of hats is equivalent to 1·034 duals of freedom in choice of profession.

The authors may have been misled by the theory of information. In that theory the amount of information on, say, Einstein's theory of relativity is not much more than the information contained in a statement about the winner of the 2.30, but in the theory of information we are concerned with communication problems and it is true that it takes just about as long, or the same

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

order of magnitude in the length of a telegram, to communicate the form of Einstein's equation of relativity as to communicate the winner of the 2.30. From the point of view therefore of electricity consumption and the strain on the Post Office there is an equivalence between these two concepts. But I have no basis on which to equate the measure of freedom of choice of hats with freedom of choice of profession.

How much political or cultural freedom, if any, we are prepared to sacrifice in order to have a choice of television programme I do not know. It seems that the authors have emphasized that the choice involved in the measure of freedom should be of an homogeneous character; we should put choice of profession with choice of domicile and choice of hats with choice of socks but to mix the two would be foolish.

The second point of criticism, that relating to the sweeping operations they use to deal with a situation where the choice is an unreal one, has to some extent been anticipated by Mr. Gabor in introducing the paper. Referring to p. 53, 2 states: "If we find a group of m choices, such that the fractions $p(i)$ of those who elect them are equal, and if any one of the choices i is cancelled its customers will distribute themselves evenly over the remaining $m - 1$ choices, we consider this group as representing only *one* choice". It seems to me that one might take a group of people some of whom are exceedingly keen to become painters, others musicians, and others scientists—and if they were in the right sort of social stratum these professions might represent alternatives to them—but those who want to be painters are so keen that if in fact they are prevented they will choose one of the other professions at random. In that situation the authors would regard that choice as a matter of complete indifference whereas in actual fact it would be entirely the reverse. That is covered by the authors in the introduction where they say that one has to use a certain amount of commonsense, but I think that rather introduces another subjective factor. If one is to use commonsense one might as well ask oneself whether the choices are different or not, and not have an elaborate method with a false appearance of objectivity.

Finally, I wonder if the authors would make a little clearer what they mean by "utility" in the beginning of the mathematical part of the paper. Except for saying what it does *not* mean they seem to leave it indefinite and yet at the same time (p. 44) seem to use an intuitive property of it at a crucial stage. It does not seem to me that a choice made by anyone should not have a finite amount of utility.

I should like to refer again to section 7. I feel the authors tend to play down the importance of statistics and scientific work generally in the maintenance of freedom. Our President has drawn attention to the importance of logic in freedom of thought and the importance of an objective theory of statistical inference in this connection. It is not long since some of us listened to a short but very moving address at the International Statistical Institute by the President of Italy during which he reminded the Institute of the difficulties which statisticians had to face under the Fascist régime in Italy and the valuable service to the cause of freedom rendered by the fact that statisticians were not prepared to falsify their data under political pressure; and I think if we take some examples, such as Wordsworth, the poets do not come off so well in this connection.

If we disagree with the authors' definition does it mean that we feel that their whole effort is wasted? I for one do not. The projection of mathematics into any argument, even though it turns out irrelevant, always has a pacifying influence, because it is not possible to calculate and do algebra in hot blood. At this time when the world seems in danger of splitting because of lack of calm discussion, anything which contributes to such pacification is welcome, and in that sense I have much pleasure in moving a vote of thanks to the authors.

Professor CHAMPERNOWNE: This paper is concerned with the measurement of opportunities for choice. This is a subject of some importance since in evaluating policy one often has to weigh up the advantages of greater production through standardization against the disadvantages of less variety for selection. It is well known that straightforward methods of comparing the real incomes of two communities or the same community at different times give little or no credit to greater variety. Variety is a luxury and the importance of variety is likely to grow as more urgent needs are satisfied and the standard of living rises. Special interest, therefore, may be aroused when an arts man and a scientist pool their skills to measure the variety of choice. The objective approach to the subject is especially to be encouraged since the economic value of variety is a subject about which prejudices are rife. On the one hand, those whose policy aim is the universal satisfaction of basic economic needs seem sometimes to ignore the value of variety. On the other hand, those who seem to measure the importance of man's needs by the power of his purse, exaggerate the importance of variety even more than that of other luxuries.

Having welcomed the paper, I pass to criticism and appreciation. With many papers, the best method of criticism and appreciation is to attack the problems afresh for oneself: It is so

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with this paper, and I will adopt that method hoping that there may be some interest in comparing the results obtained by a slightly different approach.

As my title I should have chosen a different one, the measurement of opportunities of choice, and I should have avoided any reference to freedom, which is a matter of high emotional content and denotes the opposite of the tyranny of man over man. Like the authors I would have insisted on the need for an objective measure of the value of opportunities of choice and I think I should have been driven to the conclusion that only the money value of such opportunities could be so measured. Opportunities of choice can be purchased and can be thought of as having a market value. People are sometimes prepared to incur the cost of travelling and a higher level of prices to secure a greater variety in the goods they buy. This might enable us to estimate a lower limit to the market value of that variety of choice. On the other hand, people are often content with lack of variety although by expending time and money they could secure it. This may enable us to set an upper limit to the value of variety.

These, I suggest, are the lines on which the economic value of variety would have to be estimated. It may be that this is a blind alley and that the attempt is impracticable. One special difficulty is the distinction between ephemeral and lasting wants. The choice of a radio set or a bed is often based on its superficial appearance, the cabinet or overlay, but the satisfaction will depend on the quality inside, the valves or the springs. The variety which affects the purchaser's behaviour *qua* purchaser is largely its appearance, whereas that which affects his eventual comments as user concerns the thing inside. It may be that the objective measure of the value of variety cannot be found on these lines.

This is not the approach of the authors of the paper who are content to define two measures, one of the diversity of choices actually made, and the other, the dependence of choices on other conditions. Denoting by $p_1 - p_m$ the proportions of persons choosing each of m alternatives diversity of choice D_i reflects the number m of choices, and also the extent to which equality of $p_1\ p_2 - p_m$ is attained. Denoting by p_{ij} the proportion of persons who are both in condition j and make the choice i, then independence of choice measures the extent to which the pattern $p_{1j}, p_{2j}\ \ldots\ p_{mj}$ is the same for each of the various conditions, that is, each of the various values of j. The product of diversity of choice and independence of choice gives a qualified diversity of choice, that is the freedom coefficient. What is the easiest way of defining such measures? For the measure of diversity one might choose something related to the values of the proportions, and the choice which, in my opinion, would have been the most convenient would be

$$D_i = 1 - \sum_{i:1}^{m} p_i^2 = \frac{m-1}{m} - m \operatorname{var} p.$$

It is a convenience that $D_i = 0$ when all make the same choice; $D_i = \frac{1}{2}$ when two choices only are made in equal strength and $D_i = 1$ approx. when choice is evenly spread over a large number of alternatives.

Similarly, for the qualified diversity, I should have thought the most convenient choice would be

$$f_{ij} = 1 - \sum_j \sum_i \left(\frac{p^2_{ij}}{p_j}\right) = \frac{m-1}{m} - m \sum_j p_j \operatorname{var} \left\{\frac{P_{ij}}{p_j}\right\}$$

and that again is equal to the weighted average of squares so one could take for the average coefficient the ratio

$$\frac{f_{ij}}{D} = 1 - \frac{\sum_j p_j \Sigma \left(\frac{p_{ij}}{p_j} - p_i^2\right)}{D_i} = 1 - \varepsilon^2_{ij} \quad \text{say.}$$

These measures satisfy the general postulates laid down in section 2 of the paper. They are easier to calculate than the logarithmic measures proposed. The tables below give these measures for comparison with the tables in the paper. It is reassuring to find that although the entries are quite different the general picture emerging from them is similar throughout to that given in the tables in the paper.

TABLE 1

Diversity Factor in British Elections

	1931	1935	1945	1950	1951
D_i . .	0·5988	0·6216	0·6403	0·6271	0·5308

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Contents of Table 2 in the Paper Recalculated according to the Simplified Formulae

$n_i \times n_j \times n_{j_2}$	$4\times4\times4$	$2\times2\times2$	$4\times2\times2$	$2\times4\times2$	$2\times2\times4$
D_i . .	0·700	0·420	0·700	0·420	0·420
$\varepsilon^2_{ij_1}$ . .	0·199	0·395	0·140	0·485	0·395
$\varepsilon^2_{ij_2}$ . .	0·117	0·144	0·057	0·144	0·153
$\varepsilon^2_{j_1 j_2}$ . .	0·028	0·017	0·017	0·006	0·051
$\varepsilon^2_{ij_1 j_2}$.	0·330	0·469	0·181	0·617	0·504
$\varepsilon^2_{ij_1 j_2} - \varepsilon^2_{ij_1}$.	0·131	0·074	0·041	0·132	0·109

TABLE 3

Coefficients of Dependence for Table 3 of the Paper

$\varepsilon^2_{ij} = 0{\cdot}095$. $\varepsilon^2_{ji} = 0{\cdot}092$
$\varepsilon_{ij} = 0{\cdot}308$ $\varepsilon_{ji} = 0{\cdot}303$

TABLE 4

Values Recalculated for the Table facing Fig. 4 in the Paper

n	2	4	8	16	32	64
Δ_i . .	0·875	0·868	0·748	0·578	0·356	0·188

If the number of choices is very large, and even the most popular choices are made by only a small proportion of people, our measure of diversity will be very nearly unity. An alternative measure for dealing with these cases is,

$$\Delta_i = \frac{1}{m \sum_{i:1}^{m} p_i^2}$$

or in the limit

$$\Delta_i = \frac{1}{\int_0^1 (P(x))^2\,dx} = \frac{1}{1 + \mathrm{var}\{P(x)\}}$$

if the scale of x can be chosen to run from 0 to 1, or, otherwise

$$\Delta_i = \frac{1}{\int_{-\infty}^{\infty} \{P(x)\}^2\,dx}.$$

This measure applied to the data in Fig. 3 gives results very similar to those of Fig. 4 but I cannot see that this example is typical of the class of case which has been discussed in the relevant section of the paper. Δ_i will be almost independent of the method of sub-division of the interval provided a smooth $P(x)$ exists giving the limit in the semi-convergent sense explained in the paper.

I have spent too long suggesting alternative answers and have left barely sufficient time for detailed criticism. In section 6, para. 1, it is stated that "the coefficients of dependence are never increased by finer sub-division of the choices". This is false. The case can arise where with a coarse division of choices they are completely independent of conditions so that dependence $= 0$, whereas with a finer division they are not independent and so dependence is positive. A simple example is

j \ i	1	2*a*	2*b*
1	·3	·2	·1
2	·2	·1	·1

Using the Gabor formulae—
$\varepsilon_{ij}^2 = 0$ if 2*a* 2*b* are merged,
$\varepsilon_{ij}^2 = 0{\cdot}0059$ if 2*a* 2*b* are separate.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

If you merge 2*a* and 2*b* you will get complete independence. If, on the other hand, you take the final sub-divisions separately there is no longer independence: it seems there is something wrong and inequality (55) is false and the very lengthy mathematical proof must contain an error. In the penultimate paragraph of section 5 it is said that the ratio of the diversities $D'x$ and $D''x$ of two populations is independent of the units in which x is measured. While this is true if the population is evenly spread over its range, it is not true except in this special case and this constitutes a serious weakness in the measure proposed. It is worth noting that if we adopt the equation for Δ_i which I have suggested then the ratio of this measure as applied to two different populations would be independent of the unit of measurement of x.

In section 8 the mathematical model is introduced which embodies certain coefficients termed utility coefficients, but we are correctly told that the utility coefficients should not be interpreted as corresponding to any of the utility concepts of economists. This is a masterpiece of understatement. So far as I can see these coefficients have no connection whatsoever with anything that anyone has dignified by the name of utility. They are simply the value of the coefficient that must be put into a certain expression in order that the authors can say that they maximize that expression.

The terminology is particularly confusing in equation (32) which expresses a normalizing convention. The unwary reader might suppose that the equation reflected an equality between prices and marginal utilities but in fact the U_i have no connection with marginal utilities.

I have read paras. 10 and 11 carefully and repeatedly and I am led to the conclusion that they do not in themselves provide any justification for the choice of the rather elaborate measures of diversity and independence which have been proposed. The authors do admit as much in the disclaimer at the end of section 8 so I will not press the point beyond saying that one can construct an equally impressive and irrelevant model to justify the simpler measures which I proposed earlier.

In section 12, the authors touch on the fundamental weakness of their whole approach; that their measure of diversity of choice could equally well be called a measure of haphazardness of choice. They propose a method of correcting for this by applying a set of rules to an unobtainable matrix of information. I may have overlooked a point here but it seems to me that a no less effective method would be to draw a number out of a hat.

I have only one further point and this may seem a little ungrateful, but I would appeal to authors not to bring words like "freedom" into their papers and still less into their titles unless this is imperative. The substantial contribution of this paper is a discussion of some novel measures of dispersion and contingency. We are always grateful for such contributions and do not need to have them gingered up by high-sounding but misleading references to freedom. Freedom, unlike heat or loudness, is an emotive word; as the authors point out, freedom is a serious subject, and I suggested earlier that it means the opposite of the tyranny of man over man; in this sense it could only be measured objectively by statistical enquiry into the manifestations of tyranny. In the world outside there are persons only too willing to claim academic respectability for their own prejudices. By affixing the label measurement of "freedom" to what is nothing of the kind, one would place means in their hands to confuse the custodians of freedom. These fears may sound exaggerated, and I hope they are.

I have pleasure in seconding the vote of thanks to the authors for their original and entertaining paper.

The vote of thanks was put to the meeting and carried unanimously.

Dr. I. J. Good thought that the speakers had come to grips with some of the main difficulties in giving quantitative expression to the idea of freedom although they did not claim to have overcome all the difficulties. For example, an extreme anarchist might say that all our political parties covered only a narrow band of the spectrum of political parties, and that the idea of the vote was merely propaganda for making people believe in the inevitability of government. The same idea arose when comparing two countries. Some people in England would regard the differences between some of the French political parties as too small for them to count as essentially different. The difficulty was like one experienced by Carnap, who tried to make credibilities depend on language only: for the sake of rigour it would also be necessary in a discussion of freedom to design a new unambiguous language, or else frankly to allow the theory to become essentially dependent on "subjective judgment". He, the speaker, thought the purpose of the theory would best be defined as the introduction of a certain amount of objectivity into one's body of subjective judgments, to increase its size and to check its consistency. In this sense the theory resembled any other scientific theory, system of theology, set of ethical principles, or principles of art criticism.

The basic section in the mathematical part of the work was section 6. The treatment there

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

seemed reasonable, being guided by the familiar idea of entropy, but it was not more than reasonable. One might well ask why F should not be defined as

$$F = \sum_i U_i[\, p(i)]^m\, [-\log p(i)]^n,$$

arising from the population parameter

$$c_{m,\,n} = \sum_i [\, p(i)]^m\, [-\log p(i)]^n,$$

a generalized measure of heterogeneity of a population, discussed in this month's *Biometrika*.*

The ultimate justification of a particular mathematical model was perhaps to be found in its consequences. The question arose then whether essentially the same consequences would follow from the model based on the generalized measure of heterogeneity instead of on entropy. If the same consequences followed then there was some arbitrariness in the definition; if they would not follow it would be interesting to prove it. It would be very satisfactory to introduce some additional convincing postulates (in section 2) and to show that these postulates led to unique definitions.

In section 8 it was stated that it was contrary to intuition to attribute a finite value to a utility which was so attractive as to concentrate the whole choice on itself. He thought utility in the ordinary sense was always bounded so that even if the speakers were using the word in a vaguer sense it could hardly be intuitively necessary to allow infinite utilities.

It would be interesting to investigate whether a measure of freedom could be tied up more with economics by defining the measure in terms of the annual payment which people would accept for the loss of certain types of freedom. Accepting a job under a contract was an example of such a transaction. The notion of freedom could not be properly considered apart from the standard of living in a country. It was not much use to have complete freedom of choice of occupation if all choices led to poverty. He assumed that lying on a bed of nails was not the best way of achieving freedom. According to Aldous Huxley it was useful even for a mystic to have a rather large income.

An important question which would repay investigations was that of the freedom of mobility of labour, freedom to change one's mind about one's work. This investigation would be a necessary complement to the one suggested by the authors concerning the choice of profession. Unfortunately, when labour was mobile it was difficult to say whether it was by choice or compulsion.

He would like to join issue concerning a matter of notation. He did not like the convention of using the argument of a function to designate the function: for example, $p(i)$ and $p(j)$ would be better called $p(i)$ and $q(j)$ or better still $p(.)$ and $q(.)$. Otherwise one ran into trouble when one gave numerical values to the arguments. He knew the convention was fairly widespread but would be surprised if there was an example of it in, say, Whittaker and Watson.

In his opinion the speakers had made an original and stimulating contribution to mathematical sociology and political science.

Professor M. G. KENDALL thought the previous speakers shared the very natural scepticism with which most people approached a paper with a title of this kind; but he thought it was also fair to the authors to pay tribute to the very balanced, clear and persuasive way in which they had presented their results. He read the first half of the paper with great pleasure and managed to cope with the second, and if he still had some doubts on the subject it was not due to the authors' incapacity but to the difficulty of the whole subject.

On the question of the use of the word freedom, he might perhaps point out that the kind of investigation discussed by the authors was already being carried out in sociology, where not one word but a set of different words was used to denote the particular quality which was being measured. He thought that dealt with Professor Barnard's distinction between hats and professions. There was in existence a good deal of data of precisely the kind with which the authors had dealt in the choice of profession, a subject which was known to sociologists as a question of "social mobility". He would be interested to see the authors' work on some of the actual data and to know how far they agreed with the conclusions which the sociologists had already reached.

The major criticism which he had of the paper was that the authors suggested that they were putting a mathematical framework on to a set of existing facts or concepts, but that the results were not mathematical artefacts. It was true that arbitrary functions could be defined but the authors went further than that and used a process of maximization.

* "The population frequencies of species and the estimation of population parameters", *Biometrika*, **40** (1953), 237–64.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The spectacle of a mathematician looking for something to minimize or to maximize was such a familiar one that it was apt to escape unnoticed. It had its roots much deeper in the human intellect than mathematics themselves. Its beginnings were to be traced in primitive society in the general belief that things were moving for the better, and in more complex societies in the development of such ideas as the greatest good for the greatest number, or that everything was for the best in this best of all possible worlds, until finally the conclusion was reached that God was a mathematician, meaning that mathematicians hoped that the Universe was moving systematically in a directional way in the most economical manner.

Such concepts in physics were undoubtedly extremely fruitful. The idea of least action, the third law of thermodynamics, the idea that a particle moved in a geodesic in space-time, were all contributions to our knowledge of the external world; but when these ideas were applied outside the domain of physics there was likely to be trouble.

In statistics such ideas as least squares, minimum chi-squares and maximum likelihood were all fruitful in their way; but even here it was possible to push the idea too far, as in what was known as the minimax principle, which said that the maximum risk should be minimized. This meant that no one would attend the Society's meetings because of the fear of being run over on the way.

In economics one defined a utility function and proceeded to assume that it existed and was continuous and differentiable. On the basis of such assumptions it was possible to deduce certain laws of reasonable behaviour. When one tried to set up social utility functions in order to maximize them one was obviously on dangerous ground. He did not propose to argue the pros and cons of that procedure; all he was trying to point out was that this process of maximization was not implicit in the social set-up but was put there by the mathematical procedure. He thought that the authors had overstated the case by saying that they were expressing what everybody knew in mathematical form.

There were two or three things he would like to say about the coefficient itself. One was that it could range from zero to infinity in general and in particular could go from 0 to n where n was the number of classes in the classification. That made it difficult to compare two different coefficients obtained from two different groupings. There was in the paper a remark that some quantity expressing freedom was 18 per cent. more than some other value, but it was not clear that a comparison of that kind had been carried out on an identical scale. He would have expected some attempt at standardizing the coefficient, for example, so as to make it vary from 0 to 1 like a contingency coefficient.

The authors also claimed that this coefficient was insensitive under continual condensation. In spite of the example which they worked out and the mathematical treatment, he still remained to be convinced about it. It seemed to him that what had happened, in a sense, was that the authors had taken a contingency table of a kind, amalgamated the rows or columns from the outside inwards and ended with much the same sort of 2 times 2 table. If one had a respectable contingency table in which the bulk of the frequency was in the middle this was apt to happen. What he would like to see would be a discussion on what happened if one took the 4 times 4 table and reduced it to the 2 times 2 table in all possible ways. It was one part of the authors' postulate that the coefficient should be invariant under any condensation of that kind.

There were two separate issues: one was what happened to the coefficient if the existing classification was condensed or expanded, and the other was what happened if the lines of demarcation were drawn at different points. One could see that something was apt to go wrong. Taking the case of choice of occupations, it was an empirical fact that practically the whole of the United Kingdom population agreed more or less on the way in which one should arrange occupations from the highest to the lowest occupation, thereby satisfying the condition for objectivity which the authors desired. It was possible to draw a line between "high" and "low" occupations in such a way as to dichotomize the number of people in the two classes, and if that was done, that is to say, if the dichotomy was 50–50, the maximum number of duals was obtained. Either he had misunderstood the situation or the coefficient had not that degree of invariance which the authors claimed for it.

One final point was that the authors required in their fifth postulate that the measure should be invariant under transformations of the order of the classes, that was to say, the result would be similar to a contingency table which was independent of the rows and columns as distinct from the correlation coefficient which was very much dependent on the order. In most social choices—and he thought they were talking here largely about social choices—the degree of choice of one category or another was not independent in that way. Reverting once again to the case of occupational groups, it was much more of an effort for a man to raise himself from Class 5 to Class 1 than from Class 5 to Class 4. It seemed necessary therefore to have some kind of weighting. That was dealt with in the case of social mobility by turning the contingency into a tied ranking. He felt that there should be an allowance for that basic fact in the authors' coefficient.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Professor BARTLETT said he would try to confine his remarks to one or two points which did not seem to have been made so far in the discussion. The first point was that a reference should perhaps be made to a book by Rashevsky called *The Mathematical Theory of Human Relations*, Chapter IX of which contained "Suggestions for a mathematical theory of individual freedom". Rashevsky did not adopt a statistical point of view, but gave one or two theoretical definitions. One was an economic definition, in which economic freedom was defined as

$$F_e = \frac{w_0 - w}{w_0},$$

where w was the rate of work required for the necessities of life and w_0 was the maximum rate of work of which the individual was capable. In another definition a freedom coefficient was given as

$$F = 1 - \frac{M - 1}{M} a N \tau,$$

where τ was the proportion of time spent in contact with others, M was the number of different combinations of activities liked by the individual in question, and N was the total size of the population. The interpretation of the second negative quantity was that it represented the incompatibility of activities desired by different individuals. There were obvious limitations in the formula; in particular, it would break down without modification if N were increased indefinitely, and also the fact that freedom was expressed as a coefficient was unsatisfactory because freedom might be regarded as increasing with the number of activities which were possible.

The authors' approach, in contrast with such somewhat arbitrary definitions, was objective and statistical, and therefore seemed one appropriate for consideration by this Society. The second point which he wanted to make was to ask the authors if they could perhaps in their verbal reply, or in the *Journal*, indicate a little more what they regarded as the next step; in view of the criticisms which had been made there would be some doubt about this. For example, the authors claimed that their theory at least provided a statistical framework which could be used for investigations, but one would rather like to have that statistical framework more or less unique. Thus the use of the logarithm occurred quite naturally in communication theory and allowed that theory, although deductive in character, to form a general basis which could be used in practice. As the earlier discussion had indicated, this was not entirely so with the authors' concepts, so that people were less likely to give unanimous approval to these.

The conclusion might be, as Professor Champernowne had suggested, that the paper provided a useful theory of choices. If the authors hoped for it to be a theory of freedom in any wider sense it seemed to be their responsibility to suggest what future action, such as the collection of data, should be taken. One difficulty here that occurred to him was that to a certain extent one could envisage in a qualitative way freedom being restricted by particular aspects of social organizations, without these necessarily being termed tyrannical. With the entirely objective and statistical definition of freedom proposed by the authors, he did not see how they could attempt to discuss such questions with its aid.

The following contributions were received after the meeting:

Dr. VAJDA: It is natural that the discussion dealt mainly with the challenging ideas of the authors on "liberty and how to measure it," but it is perhaps fitting to make some remarks about a more technical aspect. The authors have derived a coefficient and have demonstrated some of its properties, but they have not attempted to consider its sampling features (although I know, from private conversation, that they are by no means unaware of this problem). Now it is precisely such features which make an index more or less attractive when compared with alternative indices. Also in the present case there arises, in this context, an aspect less familiar in other statistical applications.

To mention the usual case first, if we decide about diversity from answers to some public opinion poll, say, then we are faced with the question of how far the resulting index reflects that which we should have obtained, if the whole population had been interviewed. This problem becomes void if, in fact, the sample comprised the whole relevant population. But another, more specific, problem arises in connection with the present paper. One feels that it is possible that those answering the interviewer's queries did not care either way and gave their answers after tossing a coin, as it were. (Professor Barnard mentioned something similar in his introduction to the discussion.) For a measure of diversity alone, this would not matter. But if diversity is to be an indication of liberty, then a low degree might have arisen, not from compulsion, but from chance.

I have not made any progress with the algebraic problems of tests of significance or of interval

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

estimation in this respect, even ignoring the appalling difficulties introduced by the purification process and it is perhaps allowed to refer to the authors' reminder about the useful modicum of commonsense, which will prevent us from concluding that our votes in the last British elections were preceded by coin tossing, although there is nothing in the results which would make such a statement algebraically absurd.

Dr. D. M. MacKay: It has been strongly argued in the discussion that the mathematical concept defined in this paper could better be named "variety" or "dispersion" of choice, rather than freedom. This agreed, we may still ask constructively why it is that freedom and unpredictability are in fact so closely associated in much of our thinking.

I believe the reason to be that in one particular case, to which I have drawn attention elsewhere,* unpredictability does measure the freedom of my choice in the morally significant sense of the term. The unpredictability concerned, however, is not that which might arise from any physical indeterminancy in the workings of my brain. It is *the unpredictability to you of what I will do if you offer me your prediction.*

It might at first appear that in making your prediction you could allow for its effect on my choosing. But a little thought shows that even if the brain were deterministic this is impossible in precisely those cases in which I would normally claim that my choosing is free, provided that you are committed to showing me your *revised* prediction. For in any such case I should always be one step ahead of you in the game.†

In fact we can go further and say that in any case in which I did not have this (operationally demonstrable) power to falsify the proffered prediction, then to the same extent my choice is lacking in freedom, in the same morally significant sense.

An involuntary twitching, say of the muscles of the arm, provides a useful illustration of an action which would not be judged "free" by this criterion, in agreement with our normal way of evaluating responsibility, and irrespective of the "variety" shown by the behaviour-pattern. It underlines the fact that the unpredictability which is morally significant is not increased, and may indeed be decreased, by any physical indeterminancy in the subject's nervous system.

If it is thought useful to have a mathematical index of freedom in this sense, it could perhaps be defined in terms of the *change produced in the reliability* of a prediction (after all possible anticipatory corrections have been made) by revealing it to the subject.

Dr. Denis Gabor, in reply, said that he was glad that there were so many good suggestions in the discussion. Whether they were intrinsically friendly to the authors' approach or not, they were all stimulating. One of the speakers hinted at the dangers of their type of approach, but he would ask if they could make any worse mess of freedom than philosophers have made in the last 2,000 years. At the least, they have thrown out a challenge to think about freedom in more precise terms. The subjective approach might have its justification, but it might be remembered that when Francis Bacon tried this approach to the concept of "heat", he classed pepper along with fire among "hot things". It was certainly progress when people agreed to measure heat with the thermometer. As regards the measure, there was much room for improvement, and it was possible that the suggestions made by Professor Champernowne or by Dr. Good would serve equally well or perhaps better. They would be looked into later.

With regard to what Professor Kendall said on the question of introducing ideas of maxima and minima into social questions, one was admittedly on not very secure ground. Nevertheless an important advantage in extremum methods was that they allowed the most concise formulation of complex phenomena. The formulation of social equilibrium in terms of maximizing a social potential which was the sum of a utility function and of an entropy-like function, was concise and elastic. The first component made for uniformity, the second for spread, and the equilibrium came about as a compromise between the two tendencies. The authors had repeatedly emphasized that their utilities are not the same as the concepts of the economists, and they quite agree with the answer which Professor Champernowne gave to Professor Barnard's question: The utility coefficients U_i are nothing else than the values which make the social potential a maximum if the choice is not restricted by conditions j. Yet the term has an intuitive justification, because if the population were pure, without a tendency to spread over the various opportunities, it would certainly tend to maximize the utility in the generally accepted sense. Introducing these concepts one could then account for any observed distribution in a way which might throw some light on

* "On Comparing the Brain with Machines": British Association Symposium on Cybernetics, September, 1953. *Advancement of Science*, (1954), **10**, 402–406

† An analogous point was made by Popper in *Brit. J. Phil. Sci.* (1950), **1**, p. 190, to show that no computing machine can predict its own future.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

its mechanism. As an example, one might be able to account for the curious triangular distribution of the audience in the Royal Statistical Society in terms of a compromise between spreading out over all available seats and their utility.

One particularly important point raised by Professor Kendall was that there is a natural and more or less generally accepted ranking of social positions, which should be taken into consideration in any formulation of freedom. He and his brother were well aware of this, but they preferred to avoid this complication for a start. Hence they considered the higher occupations on the same footing as the lower ones, and the necessity for certain proportions of the lower classes to stay in their profession had to count as freedom, just as did the ability of the higher classes to retain their less gifted sons in their own class. Obviously this was not a perfectly satisfactory measure, but it would not be difficult to extend it later by introducing some sort of ranking, which would make the measure correspond more exactly to what was considered as social justice or social utility.

This was one of the many useful suggestions which had emerged in the discussion. The authors wished to emphasize that they had no amibition to say the last word in this matter; they were quite satisfied to have said the first.

The authors subsequently replied in writing as follows:

We propose to deal with the many interesting points raised in order of the topics rather than in order of the speakers, as part of the ground has been covered several times.

There appear to be four fundamental approaches to the problem of freedom which can be characterized by the scheme "subjective/objective–individual/statistical" and each of these must be unavoidably biased by ethical or utilitarian considerations. Our "objective-statistical" approach is no exception, but, as Dr. Good has pointed out very clearly, it may be the best way of introducing objectivity into a body of subjective judgments. By taking the agreed tenets of a civilization as the basis of "good or bad" influences, we have tried to reduce subjective arbitrariness to a minimum. We have perhaps not sufficiently emphasized that not only the approval or disapproval of certain dependences, but also the ranking of the importance of opportunities is a fundamental characteristic of any civilization. This is the answer to Professor Barnard's query on the choice of profession and the choice of hats. There can be no question that our society attaches more importance to the first than to the second. How much more? is a void question; only like can be compared with like.

We must decline the subjective approach, just because logically it leads to conclusions like the saying of Burke, quoted by Professor Barnard, "That nation is free that thinks itself so". It is this way the dangers lie which have been invoked by Professor Champernowne, not in the objective-statistical approach, if it is handled with commonsense and integrity. As we are reassured by Professor Barnard, statisticians are not lacking in these qualities.

Professor Champernowne referred to the possibility of measuring the importance of freedom of choice by the money amount people would be willing to pay for it. This approach has been explored by Professor J. R. Hicks by introducing the concept of the compensating variation into economic theory, and it seems to us that the difficulties he encountered are bound to beset any similar attempt.

We are grateful to Professor Bartlett for having drawn our attention to Rashevsky's two "individualistic-objective" formulae, which both appear to us highly arbitrary, also to Dr. Mackay for his novel and interesting suggestion. Comparison of these three suggestions indicates very forcibly how immensely far we are from any working agreement once we abandon the statistical-objective approach.

This approach is, for the time being, very elastic. It would certainly be desirable to make it unique by adding a further postulate, but we could not think of one which is as inevitable and could command as general consent as our first five. Improvements may come first from testing various suggestions from the point of view of postulate 5, stability against arbitrary re-grouping, also from the point of view of significance, emphasized by Dr. Vajda, perhaps also with regard to simplicity. There is also a further criterion. We have emphasized that our mathematical process of maximizing a "social potential" is only a reformulation of facts, but we plead guilty to the secret hope that this approach might one day lead to a better insight into social dynamics. This is why we have chosen our formulae in such a way that the utility function is equal to the utility sum, and we were satisfied that this is intuitively justified, because the utility coefficients came out as $U_i = -1/\log p(i)$, which is zero for unwanted utilities, and infinite if everybody makes the same choice. This has been questioned by Professors Barnard and Champernowne and by Dr. Good. We may point out, however, that all the protagonists of the intrinsic measurability of utility, from Alfred Marshall to Sir Dennis Robertson agree that what is absolutely essential to life, such as the first glass of water, and the first morsel of food, lies outside the calculus of utility.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

By allowing infinite utility for a choice which is so compelling as to be unique, we have kept in conformity with this view, and avoided the introduction of an arbitrary utility coefficient.

Considering now the alternative suggestions of Professor Champernowne for the measures of diversity and of independence from this point of view, it is interesting to note that these too can be derived from a certain family of social potentials, $\Phi = U + F$, in which

$$U = \sum_i \sum_j \left(\frac{U_i}{p(i)^{1-1/2c} (2 - p(i))^{1+1/2c}} \right) p(i,j);$$

$$F = \sum_i \sum_j \left(\frac{U_i}{p(i)^{1-1/2c} (2 - p(i))^{1+1/2c}} \right) p(i,j) (1 - p_j(i)),$$

where c is an arbitrary constant. Applying to these the same mathematical process, that is, determining the U_i so that $\Phi = U + F$ is a maximum for the equalized, independent distribution, one obtains, apart from a constant factor,

$$U_i = p(i)^{1-1/2c} (2 - p(i))^{1+1/2c}.$$

Substituting these into the above expressions, the brackets become unity, and it can be seen that one obtains Professor Champernowne's D_i and $f_{i,j}$. These are undoubtedly simpler to compute than our measures, but we have now a social potential, or rather a family of them, which is unlikely to give much insight into social dynamics. F is entropy-like, and might be accepted, but U is not the utility sum. It is a complicated expression for which it may be difficult to find any intuitive justification.

Similarly, one may ask why we do not adopt Shannon's entropy H as a measure of diversity? To answer this question we construct a family of social potentials

$$U = \sum_i \sum_j \left(\frac{U_i}{p(i) (1 - \log p(i))^c} \right) p(i,j);$$

$$F = - \sum_i \sum_j \left(\frac{U_i}{p(i) (1 - \log \ p(i))^c} \right) p(i,j) \log p_j(i),$$

with the arbitrary parameter c. By the same process as before we find that the U_i are such as to make the brackets constant, and we obtain

$$D_i = - \sum_i p(i) \log p(i), \qquad I_{i,j} = 1 - \varepsilon^2_{i,j} = \frac{\sum \sum p(i,j) \log p_j(i)}{\sum p(i) \log p(i)}.$$

That is to say, the coefficient of independent is the ratio of the conditional to the absolute entropy, which is well known to be in the limits zero to unity. Again the measure might be acceptable, were it not for the fact that U is a somewhat arbitrary expression instead of the utility sum.

This suggests that we try a social potential which is the combination of the utility sum and Professor Champernowne's simple entropy-like expression for F, without the complicated factor, that is to say we put

$$U = \sum_i \sum_j p(i,j), \qquad F = \sum_i \sum_j U_i p(i,j) (1 - p_j(i)).$$

From this we obtain

$$D_i = \frac{1}{\sum_i p(i)/(1 - p(i))}, \qquad \varepsilon^2_{i,j} = \sum_i \frac{1}{1 - p(i)} \sum_j \frac{1}{p(j)} [p(i,j) - p(i)\, p(j)]^2.$$

These are expressions simpler than the ones which we have proposed; as simple as Professor Champernowne's, and not subject to the objection that they are derived from a U-function devoid of intuitive meaning. But we now obtain for the U_i, apart from a constant factor

$$U_i = 1/(1 - p(i)).$$

This becomes infinite if all the population makes the same choice, but it has a constant, finite value for $p(i) = 0$, that is to say for the choices which nobody wants. Hence it would be difficult to interpret it as a utility coefficient.

These considerations suggest that though our proposals are not unique, it is not easy to find substitutes with equally good intuitive justification and with the added advantage of simplicity. Hence our choice is not as arbitrary as it might look at first sight.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

We are very grateful to Professor Champernowne for having pointed out an error in our statement regarding the behaviour of the coefficient of dependence with progressive subdivision of the choices. It was wrong to state that subdivision can never lead to an increase; in fact starting from an independent distribution, as in Professor Champernowne's example, any subdivision can only result in an increase; moreover a "checkerboard partition" will have the same effect, applied to any distribution. We have now corrected the statement and restricted it to the case, which one must ultimately reach if the division is pushed far enough, in which one finds "proportional partition", i.e., indifference to the finer distinctions in the choices. This correction is most welcome, because the corrected statement enables us to give a more satisfactory answer to a pertinent question put by Professor Kendall.

Professor Kendall questioned the stability of the coefficient of independence in the case of regrouping. Following his suggestion, we have investigated what happens if one takes our 4×4 table of son's profession i and father's profession j_2, and reduces it to 2×2 tables in all possible ways. This is the key to the reduction into groups I and II:

Son's profession i. Symbol	A	B	C	D	E	F	G
Father's ,, j_2 ,,	a	b	c	d	e	f	g
I contains previous groups .	1	2	3	4	1, 2	1, 3	1, 4
II ,, ,, ,, .	2, 3, 4	1, 3, 4	1, 2, 4	1, 2, 3	3, 4	2, 4	2, 3

This gives 49 different 2×2 tables (not counting interchange of I and II), resulting in the values of $\varepsilon_{i,\, j_2}$ listed below:

	a	b	c	d	e	f	g
A .	·358	·144	·177	·183	·271	·214	·244
B .	·151	·201	0	·062	·040	·150	·185
C .	·173	·046	·207	·069	·227	0	·126
D .	·113	·060	0	·270	·177	·112	·054
E .	·229	·081	·184	·251	**·324**	·075	·074
F .	·214	·151	0	·116	·075	·213	·139
G .	·281	·149	·172	0	·149	·139	·274

These are indeed "all over the place". There is no stability in the case of arbitrary regrouping, and our previous rules must be modified to deal with this general case. Unless there is some "natural" classification, the only way to obtain agreement is to work for the *largest* dependence obtainable from the statistical material. This may not entail such prohibitive work as might appear at first sight. By the law that other things being equal the largest dependence is obtained with the finest available sub-division of the factors, it is only necessary to consider this, i.e., in the present case the work of grouping the factors could have been avoided by adopting for these the original division into 4 groups. As regards the choices, in principle all divisions and groupings must be tested, but even this work may be made much easier by a little insight. For instance in the present case the second largest ε, 0·324, is obtained at E, e, which corresponds to the division of the classes into an upper and a lower half, and an even larger value, 0·358, is obtained by taking the "top class" 1 versus the rest. This is just what one would have expected instinctively.

The normalized diversity in section 13 appears to answer Professor Kendall's call for a standardized measure which varies from zero to unity.

Our process of "purification" has been questioned by Professors Champernowne and Barnard. We do not agree with Professor Champernowne that the matrix of secondary choices is necessarily unobtainable. We could not, in the space available, accommodate all the cautioning remarks which we have thought of, nor can we do this now, but it is easy to deal with the rather extreme case mentioned by Professor Barnard. If the population is *compelled* to make a second choice, the diagonal of the matrix will be empty, and this is sufficient warning not to apply the sweeping operation, which in this case would indeed give a meaningless result.

Regarding the question of constructing manageable trivariate and multivariate tables, raised by Professor Barnard, we think that our Table I, the design of which is by no means novel, provides a convenient example. More complicated material can be broken up into sub-tables, as in mathematical tables of multivariate functions. However, the time may not be far distant when such tables will no longer be printed but kept in the form of punched cards, magnetic discs and the like in institutes housing electronic computors; only lists of tables will be printed and circulated. As regards our notation, we quite agree with Dr. Good that it has some unsatisfactory features, but we thought it better not to depart from Shannon's notation.

We particularly appreciate the friendly encouragement received from Professors Kendall and Bartlett regarding the continuation of this work. One line will be the application of the methods

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to real statistical material. We could not as yet lay our hands on appropriate British figures, but we have made a start with some Swedish statistics corresponding to our Table 1, and hope to publish the results in due course.

Progress in the direction suggested by Professor Kendall, embodying *ranking* in the measure of freedom when applied to social phenomena also appears to us of the first importance. Perhaps the most urgent of theoretical problems is to decide on the best possible statistics from the point of view of sampling fluctuations, before letting the mathematical framework set rigidly in the mould. This is a work which the present authors can hardly expect to carry alone to a satisfactory finish; we hope that it will arouse the active interest of the most expert theoretical statisticians. As an ultimate practical goal, which we can even less hope to reach by ourselves, we consider the study of man in a free society, which will be no less free for having a quantitative grasp of its freedom, and knowing its limitations.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Raymond Douglas Cooper.
Conor John Donelan.
Rees Evan Evans.
Helen Millecent Ferres.
Ronald Ernest Fry.
Kathleen Emily Gales.
Jack Henry Hayter.
Robert Arthur Healing.
Robert Elfyn Hughes.
Charlotte Kipling.
Gillian Mary Moul.
Bertram Desmond Misselbrook.
John Allen Newman.
Ernest Leslie Osborne.
Douglas Howell Rees.
Kodikara de Silva.
David Glyn Thomas.

Corporate Representatives

L. Perk Vlaanderen, *representing* The International Rubber Study Group.
S. M. Rix, *representing* The British Electricity Authority.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Length of Life of Musicians

By Milton da Silva Rodrigues

(University of São Paulo, Brazil)

From time to time the question arises whether or not artists, on the average, live longer than ordinary men. The present study offers a contribution to the answer, in so far as musicians are concerned. Previous contributions, so far as known to the author, were made in 1833 by R. R. Madden, who studied twenty musicians and, in this century, by Dublin and Lotka, who studied eighty-one.

The present author has endeavoured to take as many composers as possible, but only those who could be described as *famous*. Names were taken from cumulative gramophone record catalogues (78 r.p.m., and long-playing), and to these were added one Portuguese and five Brazilian musicians, all of high reputation in Brazil although no recording of their music is known. In this way 317 names were obtained. The method of selection ensures that these 317 musicians are people whose work still arouses public interest.

The dates of birth of 34 out of these 317 were uncertain and of one, the date of death was uncertain. In only one case did the uncertainty amount to as much as five years. These 35 musicians are not included in the computations for this paper on which conclusions are based.

Ages at death were computed simply by subtracting the year of birth from the year of death. Table 1 lists alphabetically the musicians included in this investigation.

Table 1

Abaco (1675); 67
Abel, C. P. (1725); 62
Adam (1803); 53
Adam de la Halle (1230?); 57
Aichinger (1564); 64
Albeniz (1860); 49
Albert, Eugen (1864); 68
Albert, Heinrich (1604); 47
Alkan (1813); 75
Allegri (1582); 70
Anerio (1567?); 54
Arbos (1863); 76
Arcadelt (1514?); 61
Archangelsky (1846); 78
Arditi (1822); 81
Arensky (1861); 45
Arne, T. A. (1710); 68
Asioli (1769); 63
Astorga (1680); 76
Attwood (1765); 73
Auber (1782); 89

Bach, J. C. (1735); 47
Bach, J. S. (1685); 65
Bach, K. P. E. (1714); 74
Bach, W. F. (1710); 74
Balakiref (1837); 73
Balfe (1808); 62
Bazzini (1818); 79
Beethoven (1770); 57
Bela Bartok (1881); 64
Bellini (1801); 34
Bellman (1740); 55
Benedict (1804); 81
Berard (1565); 60
Berg (1885); 50
Berlioz (1803); 66
Billings, W. (1746); 54
Bishop (1786); 69
Bizet (1838); 37
Boccherini (1743); 62
Boieldieu (1775); 59
Boito (1842); 76
Bolzoni (1841); 78
Borodin (1834); 53
Bortniansky (1752); 73
Boyce (1710); 69
Brahms (1833); 64
Bruch, Max (1838); 82
Bruckner (1824); 72
Brumel (1480?); 40
Brumeau (1857); 77
Bull, John (1563); 65
Busoni (1866); 58
Buxtehude (1637); 70
Byrd (1543?); 80

Cabanillas (1644); 68
Cabezòn (1510); 46
Caccini (1545?); 73
Caldara (1670); 66
Campra (1660); 84
Caplet (1879); 46
Carissimi (1605); 69
Casella (1883); 64
Catalani, A. (1854); 39
Cavalli (1600); 76
Chabrier (1841); 53

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1—*continued.*

Chambonières (1602?); 70
Chaminade (1857); 87
Charpentier (1634); 70
Chausson (1855); 44
Cherubini (1760); 82
Chopin (1810); 39
Cilea (1866); 84
Claude le Jeune (1528); 72
Clementi (1752); 80
Clérambault (1676); 73
Coleridge Taylor (1875); 37
Corelli (1653); 60
Cornelius (1824); 50
Costeley (1531); 75
Couperin le Grand, F. (1668); 65
Couperin, Louis (1626?); 35
Couperin, Pierre Louis (1755); 34
Cui (1835); 83

Dalayrac (1753); 56
Dalcroze, Jacques (1865); 85
Daquin (1694); 78
Dargomijsky (1813); 56
David, Félicien (1810); 66
Davies, H. W. (1869); 72
Debussy (1862); 56
Delibes (1836); 55
Delius (1862); 72
Donizetti (1797); 51
Dornel (1685?); 80
Dowland (1563); 63
Dubois (1837); 87
Dufay (1400?); 74
Dukas (1865); 70
Dunstable (1370); 83
Duparc, H. (1848); 85
Durante (1684); 69
Dussik, J. L. (1760); 52
Dvorak (1841); 63

Elgar (1857); 77

Falla (1876); 70
Farnaby (1560?); 40
Fauré (1845); 79
Fibich (1850); 50
Field (1782); 55
Finck (1445?); 82
Flotow (1812); 71
Foster, Stephen (1826); 38
Franck, César (1822); 68
Frank, Melchior (1573); 66
Francoeur (1698); 89
Franz (1815); 77
Frescobaldi (1583); 60
Froberger (1616?); 51

Gabrielli (1557); 55
Gade (1817); 73
Gagliano, Marco da (1575?); 77
Galilei, Vincenzo (1520); 71
Galliard (1687?); 62
Geminiani (1687?); 75
German (1862); 74
Gershwin (1898); 39
Gibbons (1583); 42
Gigout (1844); 81
Giordano (1867); 81
Glazunof (1865); 71
Glinka (1803); 54
Gluck (1714); 84
Godard, B. (1849); 46
Goldmark, Carl (1830); 85
Gomes, A. Carlos (1836); 60
Gounod (1818); 75
Gossec (1734); 95
Goudimel (1505?); 67
Granados (1867); 49
Grétry, A. E. M. (1742); 71
Grieg, Ed. (1843); 64

Haendel (1685); 74
Haessler (1747); 75
Hahn (1874); 73
Halévy (1799); 63
Hassler (1564); 48
Haydn, F. J. (1732); 74
Haydn, M. (1737); 69
Heller (1814); 74
Herold (1791); 42
Herz, H. (1806); 82
Hiller, J. A. (1728); 76
Himmel (1765); 49
Holst, G. (1874); 60
Humperdinck (1854); 67

d'Indy (1851); 80
Ingegneri (1545?); 47
Ippolitof Ivanof (1859); 76

Janáček (1854); 74
Jannequin (1475?); 85
Jensen (1837); 42
Jommelli (1714); 60
Josquin des Près (1445?); 76

Kuhlau, F. (1786); 46
Kuhnau, J. (1660); 62

Lalande (1657); 69
Lalo (1823); 69
Lassus, O. de (1532?); 62
Leclair (1697); 67
Legrenzi (1697); 64
Lehár (1870); 78
Leo (1694); 50
Leoncavallo (1858); 61
Liadof (1855); 59
Liszt (1811); 75
Locatelli (1693); 71
Loeffler (1861); 74
Lortzing (1801); 50
Lotti (1667?); 73
Luigini (1850); 56
Lully (1632); 55

Macdowell (1861); 47
Machaut (1300?); 77
Mahler (1860); 51
Marcello, Benedetto (1686); 53
Martin y Soler (1754); 52
Martini, Pe. G. B. (1706); 78
Martini, G. P. (1741); 75
Martucci (1856); 53
Mascagni (1863); 82
Massenet (1842); 70

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1—*continued.*

Mattheson (1681); 83
Mauduit (1557); 70
Méhul (1763); 54
Mendelssohn (1809); 38
Messager (1853); 76
Meyerbeer (1791); 73
Miaskowsky (1881); 69
Miguez, Leopoldo (1851); 54
Monteverdi (1567); 76
Moscheles (1794); 76
Moskowsky (1854); 71
Mouret (1682); 56
Mozart, L. (1719); 68
Mozart, W. A. (1756); 36
Mussorgsky (1839); 42

Nanino, G. M. (1545?); 62
Nardini (1722); 71
Nepomuceno, A. (1864); 56
Neukomm (1778); 80
Nicolai, Otto (1810); 39
Nielsen, Carl (1865); 66
Nune Garcia, Pe. J. M. (1767); 63

Obrecht (1450?); 55
Offenbach (1819); 61
Okhegem (1420?); 75
Oswald, Henrique (1852); 79

Pachelbel (1653); 53
Pacini (1796); 71
Paer (1771); 68
Paganini (1782); 58
Paisiello (1740); 76
Palestrina (1525); 69
Paradies, D. (1710); 82
Pasquini (1637); 73
Pergolesi (1710); 26
Peri (1561); 72
Pezel (1639); 55
Philidor, F. A. (1726); 69
Piccini, N. (1728); 72
Pick-Mangiagalli (1882); 67
Pierné (1863); 74
Planquette (1848); 55
Ponchielli (1834); 52
Popper (1843); 70
Porpora (1686); 80
Portugal, M. A. (1762); 68
Pretorius (1571); 50
Puccini (1858); 66
Pugnani (1731); 67
Purcell, H. (1659); 36

Quantz (1697); 76

Rachmaninof (1873); 70
Rameau (1683); 81
Ravel (1875); 52
Rebikof (1866); 54
Reger (1873); 43
Reicha (1770); 66
Respighi (1879); 57
Reusner (1636); 43
Reznicek (1860); 85
Rheinberger (1839); 62
Richter, F. X. (1709); 80
Rimsky-Korsakof, N. A. (1844); 64
Rossini (1792); 76
Roussel (1869); 68
Rubinstein, Anton (1829); 65

Saint-Saens (1835); 86
Salieri (1750); 75
Sammartini (1701); 74
Sarasate (1844); 64
Sarti (1729); 73
Satie (1866); 59
Scarlatti, A. (1660); 65
Scarlatti, D. (1685); 72
Scheidt (1587); 67
Schoenberg (1874); 77
Schubert (1797); 31
Schuetz (1585); 87
Schumann, R. A. (1810); 46
Scriabin (1872); 43
Senaillé (1687); 43
Séverac (1873); 58
Smetana (1824); 60
Soler, A. (1729); 54
Sor (1778); 61
Spohr (1784); 75
Spontini (1774); 77
Stamitz, Carl (1746); 55
Strauss, Johan I (1804); 45
Strauss, Johan II (1825); 74
Strauss, Richard (1864); 85
Suk (1874); 61
Sullivan (1842); 58
Suppé (1819); 76
Svendsen (1840); 71
Sweelinck (1562); 59
Szymanovsky (1883); 54

Tarrega, Fr. (1854); 55
Tartini (1692); 78
Taverner (1495?); 50
Tchaikovsky (1840); 53
Telemann (1681); 86
Thomaz, Ambroise (1811); 85
Tiersot (1857); 79
Torelli (1658?); 50
Tosti, F. Paulo (1846); 70
Traetta (1727); 52

Veracini (1690); 60
Verdi (1813); 88
Viadana (1564?); 81
Victoria (1535?); 76
Vieuxtemps (1820); 61
Vinci (1690); 40
Viotti (1753); 71
Vivaldi (1675?); 66

Wagner (1813); 70
Weber, K. M. (1786); 40
Weelkes (1575?); 48
Widor (1845); 92
Wieniawsky, H. (1835); 45
Willaert (1480?); 82
Wolf, Hugo (1860); 43
Wolf Ferrari (1876); 72

Zandonai (1883); 61
Zingarelli (1752); 85

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The arithmetic mean of ages at death, for the whole group, was found to be 64·8 years. Averages for different centuries were found to be:

1. For musicians born in the sixteenth century: 64·5 years (23 observations).
2. For musicians born in the seventeenth century: 65·1 years (41 observations).
3. For musicians born in the eighteenth century: 65·1 years (72 observations).
4. For musicians born in the nineteenth century: 64·4 years (146 observations).

Two tests showed that ages at death are not significantly related to period. Following this conclusion, a single life table was computed. Owing, however, to the scarcity of data, only constants for quinquennials were computed, on the hypothesis of a uniformly distributed force of death in each quinquennial. The calculated expectations of life are shown in Table 2.*

TABLE 2

Complete Expectation of Life, $\mathring{e}_x$, for the Population of Musicians of Table 1

Age x	30	35	40	45	50	55	60	65	70	75	80	85	90
$\mathring{e}_x$	37·00	32·60	28·65	25·10	21·65	18·00	15·35	12·25	9·30	7·50	6·75	5·45	4·60

TABLE 3

Frequency Distribution of Ages at Death, for Quinquennials centering around x.

Age x	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Frequency	1	6	12	17	17	31	26	31	47	46	25	17	4	1

TABLE 4

Showing the Complete Expectation of Life According to Certain Tables

Age	*Musicians*	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*
20	—	33·9	33·4	39·5	43·0	41·0	45·8	47·8
25	—	30·7	30·1	36·1	39·2	37·0	41·6	43·3
30	37·00	27·6	28·3	32·8	35·3	33·1	37·4	38·8
35	32·60	24·8	25·7	29·4	31·3	29·2	33·3	34·4
40	28·65	22·1	23·1	26·1	27·4	25·6	29·2	30·0
45	25·10	19·5	20·5	22·8	23·6	22·2	25·2	25·9
50	21·65	17·1	18·0	19·5	20·0	18·9	21·4	22·0
55	18·00	14·8	15·6	16·4	16·8	15·8	17·7	18·3
60	15·35	12·3	13·2	13·5	13·9	12·9	14·4	15·1
65	12·25	10·0	10·9	10·8	11·4	10·3	11·4	12·1
70	9·30	7·7	8·6	8·4	—	8·0	8·8	9·4
75	7·50	7·5	6·5	6·5	—	6·2	6·6	7·2
80	6·75	—	4·8	4·9	—	4·6	4·9	5·4
85	5·45	—	—	—	—	—	—	4·0
90	4·60	—	—	—	—	—	—	3·1

Source of Calculations of Expectation of Life:—

I: Halley's Table expressed in modern form, second half of the 17th century.
II: Northampton Table, 1735–1780.
III: English Life no. 3 (males), 1838–1854.
IV: Gotha Life Off., 1829–1896.
V: English Life no. 6 (males), 1891–1901.
VI: English Life no. 9 (males), 1920–1922.
VII: United States Life Table, 1939–41.

The general mean found by R. R. Madden was 64 years, and that found by Dublin and Lotka, 62·27 years. When making comparisons with data of the general population, one should take into account the fact that our distribution of deaths is truncated, so that it would not be legitimate to compare the mean age at death of musicians with the mean age at death of the general population, because of the influence on the latter of high mortality rates at lower ages. Comparisons of expectation of life at later ages seem more legitimate. We have therefore shown, in Table 4,

* For this calculation I must thank Professor Nuno Fidelino de Figueiredo, University of São Paulo.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5

Frequency Distribution of Sample Means $\bar{x}_i$

$\bar{x}_i$	56	57	58	59	60	61	62	63	64	65	66
Frequency	1	1	4	3	13	15	12	7	8	1	1

Arithmetic mean of the $\bar{x}_i$: 61·29.

TABLE 6

Musicians	*Votes*
1. Beethoven	66
2. Mozart	65
3. Bach, J. S.	60
Chopin	,,
4. Debussy	59
Schubert	,,
5. Brahms	57
6. Handel	56
Schumann	,,
7. Ravel	53
8. Haydn	51
9. Liszt	49
10. Mendelssohn	47
11. Albeniz	45
12. Grieg	44
13. Franck, Cesar	43
Tchaikowsky	,,
14. Rachmaninof	42
Wagner	,,
15. Gluck	41
Rimsky-Korsakof	,,
16. Saint-Saens	39
17. Bizet	38
Falla	,,
Mussorgsky	,,
18. Strauss, R.	35
Vivaldi	,,
19. Dvorak	33
Verdi	,,
20. Paganini	31
21. Berlioz	30
Gomes, C.	,,
Respighi	,,
22. Massenet	29
23. Borodin	27
Palestrina	,,
Scarlatti, D.	,,

Musicians	*Votes*
24. Corelli	26
Mascagni	,,
Pergolesi	,,
25. Rossini	25
26. Fauré	24
27. Boccherini	23
Weber	,,
28. Gounod	22
Puccini	,,
29. Offenbach	21
30. Granados	20
Oswald, H.	,,
31. Frescobaldi	19
21. Bella Bartok	17
Donizetti	,,
Gershwin	,,
Rameau	,,
33. Couperin le Grand, F.	16
34. Bach, J. C.	15
Chaminade	,,
Moskowsky	,,
Nepomuceno, A.	,,
Strauss, J. II	,,
35. Monteverdi	14
Purcell	,,
36. Bach, K. P. E.	13
Bellini	,,
Boïte	,,
Sarasete	,,
Smetana	,,
37. Dukas	12
38. Chausson	11
Lehar	,,
Mahler	,,
39. Carissimi	10
Clementi	,,
Bruckner	,,
Buxtehude	,,
Rubinstein	,,
Scriabin	,,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the expectation of life shown in Table 2, together with those derived from other life tables. Although it is well known that expectation of life for the general population has been greatly increasing, that of our population of musicians appears to be constant. The arithmetic mean of their years of birth is 1771; this is a baricentre of all births, which seems to suggest this year as the best one for comparisons.

Some facts may help in the appreciation of such comparisons. Biographies of musicians generally show that they have become known by their works at a relatively early age. On the other hand, many musicians widely known to-day had been forgotten for a long time, until the efforts of musical societies and musicologists rescued their works from oblivion and brought about their present fame. This is true of many early musicians who, independently of their age at death, achieved fame in a small circle, were forgotten soon after their death and have only in recent years attained a world-wide celebrity. Modern means of communication thus affects early and recent musicians in much the same degree.

TABLE 7

(v)	(n_i)	(w_i)	(W_i)	(N_i)	(W_i/N_i)
65–69	2	93	93	2	46·50
60–64	2	104	197	4	49·25
55–59	5	271	468	9	52·00
50–54	2	126	594	11	54·00
45–49	3	162	756	14	54·00
40–44	7	483	1239	21	59·00
35–39	5	320	1559	26	59·96
30–34	6	392	1951	32	60·97
25–29	8	508	2459	40	61·48
20–24	8	511	2970	48	61·88
15–19	11	695	3665	59	62·12
10–14	17	1062	4727	76	62·20
5–9	30	2032	6759	106	63·76
1–4	82	5248	12007	188	63·87
0	94	6267	18274	282	64·80

N.B.—In this Table musicians with uncertain ages have been included, but neglected in computations.

v = number of votes cast to a musician.
n_i = number of musicians that received v votes.
w_i = total number of years lived by musicians that received v votes.

$$W_i = \sum_{j=1}^{i} w_j.$$

$$N_i = \sum_{j=1}^{i} n_j.$$

Musicians with uncertain age at death were not considered.

There is a popular belief that artists, in general, do not live long. Popular opinion is, of course, strongly influenced by those artists who are more widely known. In order to test the effect of selection by popular opinion on the length of life of musicians, the author started an inquiry among music-loving people and some professional musicians. After deleting the age at death in the list of Table 1 the table was sent to some people who were asked to check at most 50 names of their personal preference. Sixty-six questionnaires were answered. The mean age at death was computed for the musicians selected in each questionnaire. Out of these 66 sample means only two were found to be higher (65·33 and 65·00) than the general mean (64·80). The probability of having 64 or more sample means smaller than the general mean, on the hypothesis of chance variation with equal probability for greater and smaller values, is of the order of 10^{-16}, which shows that selection by preference decidedly lowers the average length of life of musicians. The arithmetic mean of the sample averages was found to be 61·39 years. The frequency distribution of these averages appears in Table 5.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The musicians were classified* according to the number of votes they received, but only the names corresponding to the first 39 places appear in Table 6, where musicians who received the same number of votes occupy the same rank. As the question here is one of discrimination by preference, which is not a particularly sensitive criterion, it seemed advisable to group the data. The grouped data are shown in Table 7. The means $\bar{y}_i = W_i/N_i$ that appear in the last column of this table are the average lengths of life for groups that grow in size through the addition of less popular musicians. If we plot the values of $\bar{y}_i$ against those of N_i (size of growing group) the graph is found to suggest that $\bar{y}$ is some kind of logarithmic function of N.

Table 7 emphasizes a conclusion already mentioned, namely that in so far as the quality of a musician is measured by popular preference, "good" musicians are comparatively short-lived. This seems to point to a division of musicians into two categories: those who, with a creative genius, burned themselves out comparatively young, and those in whom discipline and method, taking the place of absent inborn qualities, contrived to save their strength and, by slowly improving in their art, at last became famous.

* Unfortunately, the name of Cimarosa was accidentally omitted from the author's list, a fact which, unforgivable by music-lovers, is not important statistically for this investigation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

International Statistical Institute, 28th Session, Rome, 1953

The 28th Session of the International Statistical Institute was held in Rome from September 6th–12th, 1953, when 160 members of the Institute were present. There were also 270 guests from Italy and 170 guests from abroad attending the meetings.

The session was opened on the morning of Sunday, September 6th, by the Prime Minister of Italy, Signor Pella, and the scientific meetings began on the following day. Two meetings were held at the same time in the mornings and afternoons and since these were in adjoining rooms, it was possible for members very easily to meet each other and to attend the whole or part of any meeting. The meetings were held in the new building of the Food and Agriculture Organisation which had rooms equipped for simultaneous translations.

The programme of meetings was:

I.—*Application of statistics to the study of productivity problems in industry*

1. General.
2. Methods of measuring productivity.
3. The rôle of different statistics as applied to the problems of measuring and improving productivity.
4. Application of statistical methods to industrial standardisation.

II.—*Regional co-operation in statistics*

5. Report on regional statistical activities (Organisation for European Economic Co-operation, Inter-American Statistical Institute, etc.).
6. Round table discussion on the place of regional co-operation in international statistical development.

III.—*Training in statistics*

7. The national and international problems of statistical training.
8. Training in relation to the application of statistics to industry.

IV.— 9. *General methodology and mathematical statistics* (4 meetings, including one on sampling).

V.— 10. *Population statistics* (2 joint meetings with the International Union for the Scientific Study of Population).

VI.— 11. *Agricultural statistics* (with particular reference to work of the Food and Agricultural Organisation).

VII.— 12. *Economic statistics.*

VIII.— 13. *Social and cultural statistics.*

IX.— 14. *Industrial applications of statistics.*

Altogether about 145 papers were contributed and printed copies of these were made available to members of the Institute on their arrival in Rome. All the papers will be issued in a bound volume later.

On Saturday, September 12th, the closing business meeting was held and the reports and financial accounts of the Institute were approved. Of special interest was a statement made of the work done at the educational training centres sponsored by the Institute in Calcutta and in Beirut, and of the dictionary of statistical terms and concepts (being prepared by Professor M. G. Kendall and Dr. W. R. Buckland for the Institute) and the arrangements being made for the translation of the dictionary into other languages.

The whole of the proceedings during the week gave valuable opportunities for informal discussions between statisticians of the different countries.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Many tributes were paid to the admirable arrangements made for the session by the Italian Arrangements Committee, and much of the success of the conference was due to the care and trouble they had taken. Apart from the social visits arranged to places of interest both in Rome and in the surrounding country, the delegates to the conference and members of their families were received at a special audience by His Holiness Pope Pius XII, at his summer residence at Castel Gandolfo.

One of the most pleasant interludes was that Professor Einaudi, President of the Italian Republic and an old member of the International Statistical Institute, came to the business meeting of the Institute on the closing day. On the same afternoon he received members at the Quirinale Palace.

Officers of the Institute were elected as follows:

President:	G. Darmois (France)
Vice-Presidents:	M. Boldrini (Italy)
	R. C. Geary (Ireland)
	H. Marshall (Canada)
	M. A. Teixeira de Freitas (Brazil)
Secretary-General:	Ph. J. Idenburg (Netherlands)
Treasurer:	R. G. D. Allen (United Kingdom)

An invitation was accepted from Brazil to hold the next session of the Institute in 1955 in Rio de Janeiro.

H. C.

Address by H.H. Pope Pius XII

At Castel Gandolfo on September 10th, 1953, on the occasion of a special audience granted to the delegates attending the 28th session of the International Institute of Statistics

(Translation from the printed French text)

You will not be unaware, Gentlemen, how much pleasure We always have in welcoming the delegates to the great scientific congresses, when, their work being finished, they pay a visit to Us.

Two years ago We received the Staff and Directors of the Central Italian Institute of Statistics, which was then celebrating the 25th anniversary of its foundation. On the present occasion We see around us experts who have come from all parts of the world to participate in the 28th Session of the International Institute of Statistics. We are very glad to take this opportunity to express to you the interest with which We follow your activities.

It is not necessary to indulge in long consideration to appreciate the importance of your Congress, to which some of the leading personalities of the nation have extended their patronage. Simply to read through the list of delegates and the extremely varied programme of subjects which you are to discuss enables one to judge the wide scope and the importance of your deliberations. Clearly, it is the intention of the organisers to contribute to the progress of research in the different fields which they have listed in your programme. Each author seeks to make some new and interesting contribution to the branch which is his speciality, while the audience find in the discussion of viewpoint and of methods a strong stimulus to their interests.

There is, however, more than this. Meetings of this kind enable the specialists of different nations to make informal contacts which are often very fruitful. Between the sessions of the Conference delegates exchange ideas, and discuss their work, and the consideration of the subjects put forward suggest many other aspects of theoretical research or possibilities of practical application.

A branch of science such as your own, so multiform and with so many ramifications, receives from meetings of this sort a far more tangible benefit than do many other faculties. We, for our own part, desire to contribute thereto, by placing before you several considerations by which We would emphasise certain aspects of the human, social and moral implications of your activities, and thereby encourage you to give yourselves to your study with yet more zeal and with yet greater disinterestedness.

The wise men of antiquity professed astonishment even then, and rightly so, at the inventive powers of the human mind. Still more in our day we admire the perfecting and the unceasing

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

adaptation of the methods used by man to learn to understand the world in which he lives. The act of knowledge consists essentially in bringing into the unity of the spirit the complexity of the material world—in discerning in the complexity of a given fact the permanent elements which explain it and which reveal its place in the order of things, and in then expressing, by means of empirical formulae, the laws which govern the observed facts. The field of the natural sciences, which is subject to the determinism of matter, provides suitable scope for this activity of the human intelligence and allows of a more ready elaboration of precise rules.

But in our day, without abandoning the study of nature, we are to an ever-increasing degree turning our attention to the sciences which concern men themselves and, in particular, we are devoting more attention to those sciences which relate to human society. In this sphere, because of the interaction of causes which are both personal and free, a large number of facts are incapable of mathematical analysis by classical methods, and seem to resist every attempt to explain them by rational and systematic means. Consider, for example, the problems of demography—movements of population, marriages, births and deaths. Furthermore, the development of social welfare organisations and of cultural institutions requires an analysis, as exact as possible, of the social groups with which these institutions are concerned and of the behaviour of those groups.

It is here that the science of statistics lends its aid; by means of its own methods, which are constantly being improved, it concerns itself with a wide variety of social facts, detects the elements which compose them, and determines their respective importance and their mutual relationship. Even at the end of the past century, penetrating minds had gained an inkling of the future developments of this technique and had realised that its efficacy was, to a large extent, dependent on the, breadth and uniformity of its application; in 1885 an International Institute of Statistics was founded, and this organisation can thus proudly claim to be one of the oldest international scientific foundations. The Institute has furnished and continues to furnish all those who study social and economic facts with an indispensable tool whose field of application grows from day to day. Has not this science even been happily applied of recent years to the study of the problems of religious faith and practice? As far as the Catholic Church is concerned there is, in certain countries, a centre of ecclesiastical statistics.

The first part of your programme is devoted to the study of the application of statistics to the problems of industrial productivity. After the destruction caused by the Second World War and its economic consequences, it is true to say that this question is of a major concern in all countries. We hope, with you, that the advance of your researches will beneficially contribute to the conditions of life of all peoples. The efforts of employers and workers would realise their maximum value and their contribution to production would be more clearly defined. This consequence alone clearly indicates the social repercussions which may arise from your work.

Notwithstanding this, step by step, with the progress of the science of statistics in proving its usefulness and indispensability in the most varied fields, there are revealed difficulties which attend its correct application and snares which beset those who use it casually. How difficult a matter it is to fix exactly the precise fact which is to form the starting-point of the investigation, to isolate the various factors whose causative rôle is to be studied. It is here that the professional qualities of the statistician are put to the test and that the need for precise methods is felt. You are therefore right to devote yourselves to improving them, to stimulating the agencies responsible for spreading them abroad and to promoting both the study and the teaching of statistics. But, since the meaning of the results depends to a considerable extent on the scope of the investigation, it is of importance that the groups of statisticians should attain true collaboration and that they should adopt identical methods. It is no easy matter to ensure the internal consistency of the results obtained by a single research worker; how much more true is this with regard to studies carried out on different lines.

Over and above this, it is quite clear that the application of statistics to the study of economic and social questions needs something more than a certain skill in mathematics; it calls also for a knowledge of man himself, of his spiritual nature and of his psychological conditions. In truth, if it be justifiable to call upon the statistician when chance or imponderable elements make difficult the explanation of a phenomenon by its causes, it is even more justifiable when the difficulty springs from the human factor, that is to say, from a network of ideas, of affections and of emotions varying with each individual, and even in constant change in the same person. After having gathered the data it is therefore necessary to be able correctly to interpret them—to assess the true value of figures which are, in themselves, meaningless. A mental effort is required to see the data anew in the living context from which they were drawn and of which they represent no more than a single aspect. This is a necessity which is forced upon the statistician, because, as We have just said, the free will of man and his inner feelings do so much to affect social facts. Think, for instance, of the fluctuations in price of certain goods, under the influence of collective optimism or anxiety produced by international events.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

When the statistician endeavours to express in mathematical quantities a system of phenomena in which free choice plays a part, his greatest danger would be to underestimate this freedom and to attribute to social facts as a whole a determinism which they do not possess, but which is implicit in his calculations, by reason of the methodological principle on which they are founded. This is a real danger to which We would draw your attention. The "law of large numbers" proves nothing which is contrary to the free will of the individual.

If statistics necessitates a certain degree of previous knowledge of human psychology it also contributes to the study of that same subject. Despite their dryness and lifelessness, numbers frequently speak with unusual eloquence. They expose situations which might well escape even an observant man. Widespread ills to which the human race is subject sometimes appear suddenly, in all the sharp relief of their deplorable data, and only the fact of their being spread over wide areas has concealed their true dimensions. While the science of statistics emphasises, by means of successive investigations certain features of social life it also reveals more clearly the detail of the individual. Tendencies which have only just begun to be felt, slight moral shortcomings, or even material or spiritual needs, are more clearly visible from large-scale studies.

If you are contributing so freely to the study of present-day society, the rapid evolution of which calls for unceasing work in development and anticipation, it is also true that great international problems will benefit from the application of your methods. In particular, we see nowadays entire peoples suddenly showing an awareness of culture, and urgently calling for considerable improvements in their conditions of life, both material and intellectual. The organisations whose care it is to assist them need information which will enable them to visualise the basic character of the problem. Here again statistics provides a means of orientating the efforts made, and in this field too you are accomplishing a task, whose scope it is Our pleasure to underline.

There is one point upon which We would insist again, since it may be said that it conditions all the rest of your work; since statistics attempts to provide information which is as exact as possible, within the limits of its methods, it is expected of him who practises the science that he should possess, in addition to that professional competence of which we have just spoken, a loyalty and sincerity above suspicion. It is useless to perfect methods if the only end they are to serve is to deceive the public more efficiently than before. The temptation is great, if we desire to give support to a particular view, to deflect the results in one direction or another, to misrepresent the truth or even to falsify awkward or embarrassing figures, from motives of cupidity or of propaganda. You will not give way to this temptation and so debase your profession. To that love of the truth which is the very soul of all scientific work you will unite that integrity of conscience which spurns all compromise, and which—to say it once again—clearly informs statistical data and the consequences deduced from them.

The many potential applications of statistics and the rôle which it is called to play in international affairs justify your desire to encourage it effectively. With full knowledge of the service you can render pursue with courage your often arduous task. May your Institute extend still wider its field of action and its scientific influence, to the greater benefit of your respective countries and of mankind at large, who will thereby be led to progress. This is Our heartfelt wish for you and at the same time We call down upon you, on your families and on your collaborators, the favour and protection of Divine Providence.

MESSAGE FROM PROFESSOR LUIGI EINAUDI, President of the Italian Republic, TO STUART A. RICE, President of the International Statistical Institute, on the occasion of the 28th Session of the Institute.

It was my most sincere wish to welcome you in person, not only and not so much as President of the Italian Republic, but even more as a member of this International Statistical Institute, to which I was elected, with great pride, nearly a quarter of a century ago.

To my great regret, various circumstances prevent me from satisfying this desire. Allow me nevertheless to say that our organization is one which people, whether men in public life, administrators or publicists, are esteeming more and more every day. Ours is an organization to which these people look for guidance useful for the common good.

Esteem first. Even a rapid glance at the titles of the papers presented by members and guests at the 28th session of the Institute is sufficient to arouse admiration for the severity of method, the efficiency of the instruments of enquiry, the acumen of the reasoning, which are, by now, the necessary basis for the daily work accomplished by theoreticians, statistical administrators and other statisticians all over the world. In our organization and in the wider circle of students and producers of statistics we find some amateurs, such as I am; there are no "promoters" or

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

quacks. In the blackest years of the Fascist and Nazi tyranny, professional statisticians may sometimes have been forbidden to publish and make use of data unwelcome to those in power; but nothing could force them to publish or underwrite false data. Economic and social doctrines *ad usum delphini*—made to order—were elaborated; but statistics that were deliberately false could not be published. Such publication was impossible because of the spreading technical "know-how" of the statisticians. And so laymen know that it is better not to ask statisticians for information which, sheltered by their complicated mathematical notations, they say they cannot give.

Nevertheless, men in public life, who are forced to make use of statistics, have a request to make of professional statisticians. They ask them to persist in their old tradition of supplying the public with clear and simple statements. Here in Rome our thoughts go back to Luigi Bodio, who started our Institute and was for long years its Secretary, and complied the first series of our "Bulletin". We again feel the pleasure experienced in long-past years when reading the results of his studies on international trade and the balance of payments of Italy. Everything he said was clear, limpid, convincing, even when he frankly declared there were many things he did not know.

Can I myself, who make use of statistics every day in the discharge of my official duties, say that I always clearly understand the data that are offered me? The data on budgets and national income are perhaps the most important of all those around which centre the interests of parliaments and governments. Can I always be sure that I have understood and remember correctly the information that has been given me?

When I read the British Budget do I always clearly remember the meaning of the distinction between the figures written *above* and those written *below* the line? In Italian statistics a distinction is drawn between taxes levied on income and those levied on consumer goods. Writers are sometimes horrified at the low rates of the former and at the high taxes placed upon the latter. Can I be sure that mistaken interpretations do not arise from technical or administrative details that are not always made clear? In estimates of the national income of many States we find income calculated at factor cost, and at market prices, the differences between the two resulting from the amounts of certain taxes. Is it likely that one per cent. of the public officials and members of parliament, for whose information and instruction these calculations are made, understand the distinction? Are they able to penetrate the mystery which accounts for the fact that some taxes which at first sight seem to be allocations or disbursements, become instead income items? Some recent estimates of national income are based in part upon information that was more or less reliable twenty years ago. Thus, these ancient data reappear in present day data after numerous additions and deductions have been made for the number of workers, for production factors, for quantities produced, for costs and prices. When I realize all this I cannot but think: Would it not have been preferable to write *Hic sunt leones?* My reaction is the same when I see that data on national savings are obtained by calculating the difference between income produced and income consumed. I reflect on the wide margins of error to which the calculations of produced and consumed income are subject and cannot but conclude that the data are too uncertain not to need many verifications and direct enquiries, and many reservations on the results obtained.

But why should a member who belongs to your organization only because he largely uses the statistical data you prepare, express so many wishes which might be construed—though they are not—as recriminations? If I venture to do so it is because I am convinced that you, and you only, can satisfy a need. This is the need, humble though it may be, for statistics to be not only serious but also popular. The character of statistics as a strictly scientific branch of knowledge is shown by your work. From one Institute session to another the contributions made by statistics to the progress of physical, biological, mathematical, economic and social sciences grow ever more valuable. There is no branch of human knowledge to which statisticians have not imparted a fresh stimulus. But there are still many others—especially the administrators of public affairs, politicians and writers—who look to your enquiries for further light. Although statistical science has now so greatly enlarged its horizons, we would remind you that the field in which it first developed was that of political, social and economic affairs. I view it to be the duty of professional statisticians to satisfy the thirst for knowledge of the users of statistics. These users should be able to obtain clear and simple guidance from data which they are able to understand and to depend upon as truthful. Only such data are fit to be used as guides by men who all too often are called on to make rapid decisions. In so doing they would like to be supported by data that can be understood, with like rapidity, and bring conviction to others.

Dear Mr. President, dear Colleagues, you will, I am sure, pardon the expression of the honest wish of your fellow member.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

Regional Economic Statistics

By K. S. Lomax

Economics Department, University of Manchester

I. Introduction

There has been in recent years an enormous increase in the amount of statistical information published relating to economic activity. It is salutary to survey such of this satiety as pertains to sub-areas or regions of the country. There is increasing realization of the importance of regional economic statistics. Regional information is vital to the government in planning and implementing its policy of maintaining full employment and a balanced overseas account, to individual business enterprises, and for private research. It is, however, by no means easy to define regions in a way profitable for all purposes. Differing uses imply differing regional areas. Nevertheless uniformity of definition is a great convenience. It is a big advantage to be able to collate statistics of population, production, employment, etc., which would be impossible if the areas to which they related were not identical.

It was, then, a considerable advance when, in March, 1946, the Treasury defined the standard regions and laid down that departments were to conform to these definitions unless good reason could be shown for diversity. Good reason has frequently been shown but the standard regions are now widely adopted. Great Britain is divided into 11 standard regions; Northern, East and West Ridings, North Midland, Eastern, London and South-Eastern, Southern, South-Western, Midland, North-Western, Wales, and Scotland. These areas, in some cases, cut across county boundaries, the North-West, for example, consisting of Lancashire, Cheshire, and the High Peak parliamentary division of Derbyshire. Full definitions and descriptions of the standard regions are to be found in such official publications as the 1951 Population Census reports, the 1948 Production Census report, the 1950 Distribution Census report and the annual reports of the Registrar-General. The main exceptions to the adoption of standard regions are in the nationalized industries. The regional structure here is usually defined on purely technical considerations which vary from industry to industry. It would also not be correct to imagine that all Government departments have found it practicable to use the standard regional structure. Most ministries have developed some form of regional organization with offices situated in the different regions but the areas adopted are not always standard. The Ministry of National Insurance, the National Assistance Board, and the Minstry of Food, for instance, adopt a grouping in which the North-West consists of Lancashire and Cheshire only. The North-Western traffic area of the Ministry of Transport comprises Lancashire (excluding the Barrow area), Cheshire and North Wales.

However, the government departments predominantly concerned with economic matters: the Board of Trade, the Ministry of Labour, the General Register office, all provide information for the standard regions.

II. Current Regional Economic Surveys

It is appropriate, in the first place, to discuss such published current comprehensive surveys of different regions as are available. In the past there have been many regional economic accounts, some purely private and others semi-official such as those carried out by certain universities for the Board of Trade in the early 1930's. At present, however, there are only two regularly published reports on economic conditions in sub-areas of Great Britain. Both of them, the economic surveys of Wales and Scotland, really owe their origin and existence to political pressure.

The White Paper on *Industry and Employment in Scotland* has been published annually since 1947. This is a comprehensive economic survey of the region covering the general economic position and conditions in all the main industries and basic services. The White Paper has usually

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

included in appendices a considerable amount of statistical information relating to the economic situation in Scotland. The recently published 1952 Survey, however, contains very few statistics. These have all now been collected together in the useful new *Digest of Scottish Statistics*, the first number of which has just appeared. It is presumably to be expected that there will be, in the near future, a considerable and important extension in the statistics on Scotland. The Catto Committee on Scottish Financial and Trade Statistics, reporting in July, 1952, concluded that while it is impracticable statistically to show Scotland's share in imports to and exports from the United Kingdom or to calculate Scotland's balance of payments with other countries including the rest of the United Kingdom, it would be practicable to produce a return showing separate Scottish and English contributions to government revenue and their shares of government expenditure. The Government having accepted this recommendation, presumably in the future this will be done.

Wales and Monmouthshire, a Report of Government Action, published annually since 1946, presents a similarly comprehensive economic picture of the region. Indeed the field covered is in some ways wider than that for Scotland. In the report on Wales considerable attention is devoted to housing, education, and the social services generally. A fair amount of statistical information on economic matters is tabulated in the Appendix. Supplementing this White Paper on Wales are the infrequent but nevertheless useful reports of the Council for Wales and Monmouthshire.

There are no other regularly published surveys on regions of the country but the references at the end of this paper include a list of the more important single *ad hoc* reports which have been written on conditions and prospects in particular areas. In addition reference is made to surveys of individual industries which often provide another source of regional material.

III. CONCENTRATED INDUSTRIES

Before considering regional economic information proper, it is important to stress that, in some respects, national data can broadly be taken as applicable to certain regions. When an industry is predominantly localized in a single area, national data of employment, production, foreign trade, etc., relating to that industry can be regarded effectively as regional information. This is a great advantage since national figures are usually both more readily available and wider in scope than regional statistics. The following table lists those industries in which roughly 80 per cent. or more of total net output for the industry in 1948 was accounted for by a single (standard) region. It is, of course, only in manufacturing industry that localization of this order is to be found. None of the industries or services in the Agriculture, Distribution, Building, Transport or Service groups possesses such a high degree of concentration.

Industry	*Percentage of Total Net Output*	*Region*
Slate quarries and mines	87·8	Wales
China and earthenware	86·0	Midland
Tinplate	94·2	Wales
Precious metals refining	78·5	London and South-East
Musical instruments	87·4	,, ,,
Cotton spinning and doubling	85·9	North-West
Cotton weaving	84·3	,,
Woollen and worsted	79·6	East & West Ridings, Yorks
Linen and soft hemp	86·9	Scotland
Jute	97·8	,,
Made-up household textiles	83·4	North-West
Textile packing	89·3	,,
Textile converting	80·8	,,
Spirit rectifying and compounding	88·4	London and South-East
Printing, publishing, bookbinding, etc.	92·6	,, ,,
Cinematograph film printing	100·0	,, ,,

For these industries, national data of employment, unemployment, production, foreign trade, capital investment, stocks, wages, profits, bank advances, etc., can be regarded as applying broadly to the region in which the industry is concentrated. It would be out of place in this paper to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

consider national statistics of the above kind. Reference should be made, however, to particular sources of information relating to some of the industries individually. The most important of these are the publications on the cotton and wool industries. None of the other trades in the list possesses central statistical organizations of the Cotton Board or Wool Industry Bureau type.

(i) *The cotton industry.—The Cotton Board Quarterly Statistical Review*, circulated privately to members of the industry, the Press and others genuinely interested contains very full quarterly information about the cotton and rayon industries. For each section of the industry, spinning, waste spinning, doubling, weaving and finishing, data are tabulated on employment, machine activity, and production. The employment figures include numbers on the books, actually working, and for spinning particulars concerning recruitment. On the equipment side, information is provided about machines in place, running, and the number of machine-hours worked per week. The production figures are very detailed indeed, yarn, for example, being broken down into nine ranges of count. Finally, very full coverage is given to activity in the main cotton manufacturing countries and to foreign trade in cotton goods.

The Cotton Board also prepares for private circulation (but again issued to the Press and others interested) a monthly return relating to weaving and a weekly return for spinning. These are in much less detail than the quarterly reviews and, in fact, cover production and employment only. Monthly data are also published regularly in the *Board of Trade Journal.*

Mention should also be made of the very useful directories for the industry. The two best known are usually referred to as "Worral's" and "Skinner's". *Worral's Lancashire Textile Industry*—an annual publication—gives numbers of firms, spindles and looms in each district of Lancashire and in total. The latest (68th) issue relates to 1953 and gives the total, but not the district, figures going back annually to 1882. There is also a Yorkshire edition of Worral's directory giving similar details for the woollen industry in Yorkshire. *Skinner's Cotton Trade Directory of the World* is particularly valuable for the large amount of foreign material included. Both directories provide a wealth of information on individual firms in the cotton industry and also supplying the trade.

Finally, while the bibliography lists the most important single publications on the cotton trade, it would be inappropriate not to refer here to the invaluable *Working Party Report on Cotton,* published in 1946, the most authoritative and comprehensive survey on the industry in recent years.

(ii) *Wool.*—The Wool Industry Bureau of Statistics is much younger than the Cotton Board so that it is not surprising to find the statistical publications on wool much less informative.

The Wool Industry Bureau Monthly Statistical Summary tabulates figures of machinery activity, productive personnel, consumption of wool and other fibres (*a*) in top-making, (*b*) in woollen spinning and felting, production and consumption of tops, and deliveries of worsted yarns, cloth and blankets.

World Wool Digest, the monthly publication of the International Wool Secretariat, provides much useful information on prices, production and trade, etc., in all the main wool-producing and wool-using countries of the world.

Finally, again, reference should be made to the *Working Party Report on Wool*, published in 1947.

IV. The Nationalized Industries

Another group of industries which should be discussed separately, for two reasons, is the nationalized sector. In the first place, the areas adopted in the regional organizations of nationalized undertakings do not at all conform to standard practice. They are usually defined on purely technical considerations. Secondly, the regional information relating to the nationalized industries is almost unique in character. The regional organization created in each case, sometimes by statute, implies the provision of detailed data on the operations of the undertakings in different areas.

The regional organization of a nationalized undertaking has usually been determined purely as a matter of technical convenience. The divisions of the National Coal Board, for example, are based on the coalfields, the North-West division including Lancashire, Cheshire, North Wales and parts of Westmorland and Yorkshire. In the case of Electricity, the British Electricity Authority, responsible for generation, has adopted a regional structure broadly co-terminous

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with the Area Electricity Boards which are responsible for distribution and sales. The North-Western division of the B.E.A. and the area of operation of the North-Western Electricity Board consists of Cumberland, Westmorland, East Cheshire, part of the High Peak, Lancashire (excluding Merseyside) and part of Yorkshire, West Riding. The North-Western Gas Board is responsible for the production and supply of gas in the area covering Lancashire, all but a fractional part of Cheshire, about half the High Peak, a fractional part of Shropshire, and of the West Riding and parts of Westmorland and Cumberland.

In transport the position is much more complicated. Annual reports of the British Transport Commission provide regional information in relation to docks, etc., and inland waterways. Railway statistics are broken down, but the railway regions, being based on the areas of operation of the main-line companies before nationalization, are not unambiguously geographic in the normal sense. Nationalized road services are, statistically, even less satisfactory. The Road Haulage Executive has created a decentralized organization consisting of eight geographical divisions, 30 districts and 207 groups, but, so far, no regional figures have been published. The road passenger services are still in the early stage of preparation of schemes for different areas. Now, of course, all road services are in the political melting-pot of the de-nationalization proposals of the present government.

For all the above reasons attention in this section is mainly concentrated on the fuel and power group. A word should be said, however, about air services, annual reports of the British European Airways Corporation and of the Ministry of Civil Aviation contain information about domestic air services within the United Kingdom. Some of this relating to traffic, fares, etc., on individual routes and traffic at individual airports can be regarded as regional economic data in some sense.

In fuel and power the principal source of statistics consists of the reports of the nationalized undertakings themselves or their area boards. The annual reports of the National Coal Board, the British Electricity Authority, the Area Electricity Boards, the Gas Council, and the Area Gas Boards contain a wealth of material relating to operations in different regions and, sometimes, in sub-areas of the regions as well. Figures on employment, capital equipment, costs, production, sales, and revenue are all tabulated in considerable detail. There are few serious omissions, although the emphasis, of course, varies. In the case of coal, for example, there is much information on absenteeism, loss of coal owing to various causes, and productivity which could not appropriately be provided for gas or electricity.

The most important of the above statistics on the coal, gas, or electricity industries in regions, divisions, or areas of the country are summarized in the very useful and comprehensive Ministry of Fuel and Power *Annual Statistical Digest*.

With regard to coal, other sources of N.C.B. divisional data are available at more frequent intervals than either Annual Reports or the Digest. The Ministry of Fuel and Power weekly statistical statement provides figures of output, tonnage lost through holidays, disputes, etc., and wage-earners on colliery books in each district and division of the National Coal Board. The employment statistics are summarized monthly in the *Ministry of Labour Gazette*. Monthly data on employment, output, tonnage lost for various reasons, productivity, earnings, etc., are to be found in the N.C.B. publication "Coal Figures". Quarterly figures of output, costs, revenue, etc., are given for each division and district in the N.C.B. Quarterly Statistical Statements on costs, proceeds and profit or loss.

In this section reference should also be made to the Ministry of Fuel and Power *List of Mines* which provides particulars of each mine in the country including numbers employed, mineral and seams worked, address and location, and senior officials. While dealing with the fuel and power group of industries it is convenient also to mention that regional information is given in the Ministry of Fuel and Power *Statistical Digest* on open-cast coal production and on coke-oven activity. Responsibility for open-cast operations having now been taken over from the Ministry of Fuel and Power by the N.C.B., statistics of this type of production will presumably in the future appear in National Coal Board reports and publications.

V. AGRICULTURE

Agriculture is another industry which, by virtue of the comprehensive information available in one source on operations in different areas, deserves separate treatment. Part I of Agricultural

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Statistics for England and Wales and for Scotland (published separately by the individual agricultural departments) contain detailed statistics for each county on employment, holdings, capital and production. The employment data are broken down as between regular and casual workers and between males and females. In the England and Wales returns holdings are classified by size only, but for Scottish counties additional information is given concerning acreages owned and rented by the occupier. This type of material is available for England and Wales in 1941–43 in the *National Farm Survey of England and Wales* (a summary report) published by H.M. Stationery Office in 1946.

The returns tabulate numbers of certain agricultural machines and implements (tractors, ploughs, binders, mowers, milking machines, etc.) in each county. The figures are provided in great detail, there being about 74 different categories of equipment. The same sources give a considerable amount of information relating to other forms of capital employed in agriculture; areas of land under the various crops and grass, numbers of livestock of different kinds, and also numbers of horses used for agricultural purposes.

Lastly are to be found production details of the principal crops in each county.

VI. Regional Economic Statistics in General

1. We come, now, to regional economic statistics of a more comprehensive kind. These are considered under the headings: definition, population, employment and unemployment, vacancies, etc., firms, factories, etc., capital equipment, production, distribution, transport, income, saving, and banking. Social statistics and statistics relating to public administration have been excluded, partly for reasons of space and homogeneity, but partly because of the nature of these other branches of the social sciences. Social statistics have been developed but to a small extent and such reliable figures as yet exist on social phenomena are to be found in such publications as the *Population Census* which are discussed. For example in the 1 per cent. sample tables of the 1951 *Population Census* are presented distributions of individuals and households in regions, conurbations, and areas of the country by social class and socio-economic group.

Public administration, which really means local government since statistics of central government activity are almost always national in scope, is in rather a different position. Firstly, local government figures essentially in concept relate to activities in local areas so that here the whole field of local government statistics and information is relevant. Secondly, local government statistics have been adequately surveyed and discussed in two important recent publications:

(i) "Local Government Statistics—with special reference to the Health Service," by B. Benjamin, *J. R. Statist. Soc.*, **112**, Part II, 1949.
(ii) *Local Government Financial Statistics*, by V. J. Oxley, published in 1951 by the Institute of Public Administration.

Thus, statistics of sociology and public administration are not considered in the sections which follow. Another restriction imposed by limitations of space is that actual statistical illustrations taken from the sources discussed have not been given. This is regrettable but unavoidable if the paper is not to extend well beyond the length suitable for an academic journal. For the same reason it has also been quite impossible to deal fully with historical material no longer currently published. There would, in fact, have been difficulty about making historical comparisons. The standard regions now universally used by the Registrar-General, the Board of Trade and the Ministry of Labour have only been adopted since the war. Previously different regional definitions applied. For example, the regional table in the 1935 *Census of Production* related to 11 regions in England, 2 in Wales and 5 in Scotland. While it was possible to combine some of these into standard regions, in the majority of cases this was not feasible. The North-West consisted of Lancashire, Cheshire, Glossop and New Mills in Derbyshire, and Saddleworth in Yorkshire. The Registrar-General divided England into 10 regions in which North IV comprised the counties of Lancashire and Cheshire only. The present Standard North-West region consists of Lancashire, Cheshire and the High Peak parliamentary division of Derbyshire.

2. *Demography.*—There are two main sources of demographic information on regions of the country, the Population Census and reports of the Registrar-General.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(i) *Population Census Reports.*

The population census is taken every 10 years in the first year of the decade. The last census related to 1951 but the full report will not be published for some years (see, however, (a) and (b) below). A census was not taken in 1941 because of the war. A count of the population by sex, age, and marital condition was, however, a by-product of the national registration of September, 1939. The last census for which a full report was published took place in 1931. In the 1931 Report population totals and distributions by age, sex and marital condition for each of twelve regions in England and Wales and for Greater London were published in the General Tables while details for all administrative areas were contained in the individual county volumes. The regional classification adopted in 1931 differed from the standard regions of 1951. The 1931 regions are usually referred to as "Geographical" regions. The North-West, for example, consisted of Lancashire and Cheshire only and was called North IV.

(a) 1951 *Population Census, preliminary report.*—A preliminary report on the 1951 Census was published a few months after the Census was taken. This contained population figures (Males, Females and Total) and acreage only for standard regions, conurbations, and all administrative areas. Corresponding figures for earlier censuses were given for comparison.

(b) 1951 *Census: One per cent. sample tables.*—An innovation in the 1951 Census goes some way towards ameliorating the shortcomings of long delays in publication. For the first time a sample of returns was analysed before the complete tabulations and the results published well within two years of the Census date. The 1 per cent. sample tables give population distributions by age and marital condition for regions, conurbations and most administrative areas. The detail in these distributions becomes less the smaller the area but in the case of regions, for example, the age distributions consist of 22 categories. Age distributions of the population are also given for divisions and sub-divisions of the conurbations. It is thus possible, for example, to compare the older built-up areas with the newer expanding residential suburbs of an area such as South-East Lancashire.

The 1 per cent. sample tables also provide fertility data. All married women classified by age at marriage and marriage duration together with numbers of children are tabulated for the standard regions.

(ii) *Reports of Registrar-General.*—Demographic data are available at more frequent intervals in reviews and returns of the Registrar-General.

(a) *Registrar-General's Weekly Returns of Births and Deaths* give birth and death registrations in the large towns. The England and Wales return, for example, provides figures for 160 large towns in England and Wales and for Edinburgh, Glasgow, Belfast and Dublin.

(b) *Quarterly Returns of Births, Marriages and Deaths.*—In the quarterly returns are given birth, marriage and death registrations not only for the large towns covered by the weekly returns but in addition for about the same number of smaller towns. The quarterly returns also provide latest estimates of the local populations in the above areas.

(c) *Registrar-General's Estimates of Local Populations.*—The Registrar-General estimates the local populations of all administrative areas each mid-year. These are published in the quarterly returns for those towns covered by this publication. The estimates for *all* administrative areas are, however, published separately. These form the most reliable population data for inter-censal years. The estimates are made on the basis of latest population census material adjusted for births, deaths, and migration.

(d) *Registrar-General's Annual Statistical Review.*—This is published in three parts: Part I (Medical); Part II (Civil); and Text. Part I contains figures of population and deaths and Part II population, births, marriages, fertility, etc., for all administrative areas. The text volume consists of commentary with additional tables.

3. *Labour.*

(i) *Employment.*

The main types of employment data for regions of the country can be classified under three headings, Censuses of Population, Production and Distribution; Ministry of Labour material; and Particular Sources for individual industries.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(a) *Census of Population.*—The occupation and industry tables of Censuses of Population provide information concerning the employment structure of administrative areas, conurbations, and regions. The final, 1951, report has not yet been published. The 1 per cent. sample tables, however, contain distributions of the occupied population (aged 15 and over), excluding persons out of work, by occupation and by industry. These are given for regions and in the case of occupations for smaller areas in addition. In view of the nature of most Ministry of Labour information it should be noted that these Population Census tables refer to the occupied population and so include employers and self-employed persons as well as employees.

(b) *Ministry of Labour* data are of two kinds, one based on the annual exchange of insurance cards and the other on direct returns made by individual firms.

Annual count of insurance cards.—The annual exchange of insurance books provides the basis of estimation of employment each mid-year analysed industrially. It should be added that since 1948 the exchange of insurance books has been staggered quarterly throughout the year. Consequently in order to estimate mid-year employment in each industry the Ministry of Labour has found it necessary, each May, to ask employers of five or more workpeople how many insurance cards they hold.

The industrial classification of mid-year insured employment in each exchange area is tabulated by the Ministry of Labour on *Employment Records II* which are not published. From these records are compiled regional and country figures which are published in the *Ministry of Labour Gazette* and separately in *Tables Relating to Employment and Unemployment in Great Britain.* Here are given data for each of the standard regions annually at the mid-year. There is unfortunately a long delay in publication. The latest complete industrial break-down relates to mid-1950 although totals for the regions at mid-1951 and 1952 have recently been published in the *Gazette.* The estimates of employment based on the annual count of insurance cards cover employees only and exclude employers and self-employed persons since data of insured employers are not considered sufficiently reliable.

L-returns

The direct employment returns made by firms to the Ministry of Labour provide estimates of the proportional monthly change in the level of employment in most industries. All employers with more than 10 employees in manufacturing industries and a sample of employers in the distributive trades and miscellaneous services are required to supply information regarding employment every month. These L-returns form the basis of the national monthly estimates of employment by industry published regularly in the *Ministry of Labour Gazette.* Regional figures based on the L-returns are not published. L-return summaries are, however, prepared on a regional basis for internal use in the Ministry of Labour. If these were made available it would be an easy matter, by taking the mid-year count figures as pivotal points, to estimate employment monthly by industry in any particular region.

(c) *Census of Production.*—In Census of Production reports on individual trades, figures have usually been given relating to output, employment, and earnings in regions of the country except when this would divulge information concerning individual firms. Unfortunately there is again considerable delay in publication. The last 1948 final report became available only in mid-March, 1953. Another drawback is that the regional break-downs are apparently not to be given for every Census of Production year. Regional information was available in 1930, 1935, and 1948, but the 1949 Census reports now being published are in a much abbreviated form and no data are given on regions of the country. While censuses subsequent to 1948 have all been on a much less comprehensive scale questions have always been asked about employment and presumably there would be no difficulty about tabulating data, say, on gross output, net output and employment regionally. The fact that this was not done in 1949, however, is rather ominous.

(d) *Census of Distribution.*—The first Census of Distribution for this country was taken in 1951 in respect of the year 1950. In Volume I of the report, *Retail and Service Trades; Area Tables*, details are given about employment in establishments engaged in the many different types of retail business. These data are provided for regions, conurbations, and all towns of over 25,000 population. For towns down to 2,500 population a figure of total employment in all retail and service trades is tabulated. Employment in the central offices and warehouses of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

different types of business is given for standard regions, totals for all types being provided also for conurbations and certain selected towns.

(c) *Particular industries.*—The individual industries for which exist particular sources of employment statistics have all been dealt with in previous sections. They are the cotton industry, the fuel and power group, and agriculture. It suffices to mention here that the publications listed contain regional employment data although the regions are not uniformly defined in the standard manner.

(ii) *Unemployment.*

The principal source of information regarding unemployment is Ministry of Labour statistics but mention should first be made of one other type of data.

(a) *Census of Population.*—The industry tables of the Population Census give the numbers out of work in regions and smaller areas classified by industry. The 1951 final report has not yet been published and regional industry tables in the 1 per cent. sample report exclude out of work. The occupation tables for the 1 per cent. sample, however, do give total numbers out of work, not classified by industry, at the time of the census, in regions, larger administrative areas, conurbations, and sub-divisions of conurbations.

(b) *Ministry of Labour.*—Ministry of Labour figures of unemployment are compiled from the numbers of insurance cards deposited at Labour Exchanges when persons become unemployed.

(1) *Ministry of Labour Gazette.*—Monthly in the *Gazette* the total unemployed in each region is analysed according to duration of unemployment, whether wholly unemployed (including casuals) or temporarily stopped, and as between men, women, boys, and girls. The percentage rate of unemployment, the number registered as unemployed expressed as percentage of the estimated total number of employees, for men, women, and totals, is also tabulated regionally. Figures for total unemployment in the larger towns are published monthly. Every six months is given a more detailed age-unemployment duration analysis of the total wholly unemployed (excluding casuals) in each region and development area of the country. There is, however, in the *Gazette*, no regular industrial analysis of regional unemployment.

(2) *Tables Relating to Employment and Unemployment in Great Britain.*—This annual Ministry of Labour publication provides for each region an analysis of unemployment at the mid-year by industry (see Section 3(i)(b)).

The above constitutes all that is published on regional or area unemployment but greater detail exists in various tables prepared by the Ministry of Labour for internal use. Some of these are issued for information, but presumably not for detailed publication, to the Press, the Universities and other interested bona-fide organizations. The nature of the more important of these statistics is indicated below.

(3) *Employment Records IV.*—The counterpart of Employment Records II but for unemployment (see 3(i)(b)). This consists of detailed figures of mid-year unemployment analysed by industry for each exchange area.

(4) *Unemployment in towns of the region.*—A table showing, each month, total unemployment in every exchange area of the region. The figures are classified, into wholly unemployed and temporarily stopped and further sub-divided into men, women, boys, and girls. Total unemployment is also expressed as a percentage of the total number of insured employees in the area.

(5) *Industrial analysis of regional unemployment.*—The Ministry of Labour also tabulates, each month, total regional unemployment analysed by industry. Males, females and totals are given for each of the Minimum List Headings of the Standard Industrial Classification.

(iii) *Vacancies Filled and Outstanding*

(a) *By Area*

(1) *Ministry of Labour Gazette.*—Each month in the *Gazette* the total number of vacancies filled (placings) and notified vacancies remaining unfilled are published for each region of Great Britain. There is, however, no published industrial analysis of the placing work of exchanges in any region.

(2) *Ministry of Labour.*—The Ministry prepares more detail on this subject for internal use

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwâr

Digitized by Arya Samaj Foundation Chennai and eGangotri

and for interested organizations. Figures are provided monthly showing placings and vacancies outstanding in each exchange area of the region.

(b) *By industry*

No published information relating to vacancies filled and outstanding in individual industries is available. The Ministry, however, circulates privately an analysis for every exchange area giving placings and vacancies outstanding, each month, in about twelve industrial groups.

4. *Factories, Firms, Shops, etc.*

(i) *Factories.*—There are at least three sources of data on factories or establishments in different areas of the country.

(a) *Ministry of Labour.*—Periodically there appears in the *Ministry of Labour Gazette* an analysis of factories in manufacturing industry (employing not less than 10 workers) by size and industrial group for Great Britain as a whole. Factories are analysed by size only, with no industrial breakdown, for regions and development areas of Great Britain. The latest figures for May, 1952, were published in December, 1952. Earlier analyses relating to December, 1949, and December, 1947, were published in June, 1950, and April, 1948, respectively.

In the past the Ministry has usually been prepared to supply bona fide research workers in, for example, the universities with more detail, as follows:

(1) A more detailed industrial breakdown. The industrial groups for which information is published in the *Gazette* are broad, corresponding to the "Orders" in the Standard Industrial Classification.

(2) Regional analysis by industry as well as by size.

(b) *Census of Production.*—The reports for individual trades in those Censuses of Production, such as 1935 and 1948 but not 1949, where regional data are tabulated give the numbers of establishments, employing not less than 10 employees, in each region except where this might divulge information on individual firms. There is no breakdown of these totals by size, however, although presumably this information could be obtained from the Board of Trade subject to the usual limitations regarding single firms.

(c) *Inspectorate of Factories.*—In the Appendix to *Annual Reports of the Chief Inspector of Factories* are given for each division and district of the Inspectorate: Numbers of factories with and without mechanical power; docks, wharves, and quays; warehouses; building operations; works of engineering construction; and inspected non-factory productive activities. There are 12 inspection divisions in Great Britain sub-divided into 92 districts. No industrial breakdown of the above figures is published in the Chief Inspector's Reports.

(ii) *Firms.*—There is no organized comprehensive analysis of firms in regions of the country. All regional analyses in the Census of Production or by the Ministry of Labour are based on establishments and not firms. The classic paper on "The Structure of British Industry", by Leak and Maizels,* analyses firms in different industries entirely on a national basis. A regional analysis of economic activity on a firm basis is not by any means straightforward either in concept or in execution. Frequently when a firm operates several establishments these are situated in different regions of the country with headquarters possibly in still another. It would, however, be very interesting and useful if some progress could be made towards estimating the contribution of large combines and independent firms to regional employment, income and output.

While no organized data exist it is possible to collect together a good deal of information relating to firms in a region from a variety of sources. Trades directories, trades association year-books, the *Stock Exchange Year-Book*, company reports and statements of chairmen, the technical press, classified telephone directories, all provide much material.

(iii) *Distribution Outlets.*

(a) *Census of Distribution.*—The 1950 Census of Distribution report on the Retail and Service Trades gives for standard regions, conurbations, and towns of over 25,000 population the number of retail and service establishments in each type of trade. Total numbers of establishments only

* "The Structure of British Industry", by H. Leak and A. Maizels: *J. R. Statist. Soc.*, 1945.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

are provided for smaller towns. These establishments are the actual selling points. Numbers of central offices and warehouses in total and in nine selected groups are also tabulated regionally. Totals only are given for conurbations and selected towns.

(b) *Britain's Shops.*—This 1952 H.M.S.O. publication—a statistical summary of shops and service establishments derived from information collected in an enumeration carried out to provide the basis for the sending out of Distribution Census forms—provides the numbers of shops and service trade establishments in standard regions, counties, large and medium sized towns. The figures are broken down in each case into 30 categories of shop type.

(c) *Marketing Survey of the United Kingdom*, edited by Cecil Chisholm, and published by Business Publications, Ltd., gives the number of retail outlets in about 135 large towns analysed (*a*) by type of trade (grocers, tailors, etc.), and (*b*) by type of shop (department store, retail co-operative, etc.). The *Marketing Survey* is normally an annual publication but the last to be published at the time of writing was that for 1951 in late 1950.

(iv) *Mines, etc.*—Regional information on the coal mines, open-cast coal sites, electricity generating stations, gas stations, coke ovens in different areas is to be found in the sources discussed in the section on nationalized industries. Similarly, the Agriculture Section covers the regional analysis of agricultural holdings.

5. *Capital Equipment*

No comprehensive information on an organized basis for capital equipment is available regionally. There are some data for the cotton, agriculture, coal, electricity and gas industries, however, in the sources mentioned in the sections dealing with these industries.

6. *Production*

There are three ways of measuring production; in physical terms, by value, and, as far as changes in production are concerned, by means of an index number. There is, at present, only one region, Scotland, for which an index number of production is regularly computed. The index appears in the new *Digest of Scottish Statistics.* Figures of regional production in physical terms are available only for a limited number of individual industries. Regional production by value in the majority of manufacturing industries is given in Census of Production reports.

(i) *Census of Production.*—In those Censuses of Production such as 1948 but not 1949, for which the reports include a regional analysis, the values of gross output and net output of each trade are tabulated regionally. In certain cases regions may be amalgamated because of the danger of divulging information concerning individual firms. None of the other production data in Censuses of Production, such as physical output figures for individual products, is broken down by region. Nor are other than national figures given for payments made to other industries for services rendered so that a truer "value added" figure for a region cannot be computed.

(ii) *Particular industries.*—Physical output data are available regionally in particular sources for certain industries. These are the fuel and power group and agriculture, already discussed, and the following:

(a) *Steel.*—In the monthly statistical bulletin of the Iron and Steel Federation production of pig iron, iron-ore, crude steel, and semi-finished steel is tabulated by district. In the case of iron-ore figures are given for 6 districts, for pig iron, 8, for crude steel, 9, and for semi-finished steel, 10. The annual statistical year-book of the Iron and Steel Federation provides more detail. In some cases the number of districts is increased while district data for finished steel products are also given.

(b) *Shipbuilding.*—*Lloyds Register Shipbuilding Returns* (Quarterly) which covers merchant ships of 100 tons gross and upwards gives particulars of work in hand in the principal districts of Great Britain and Northern Ireland. The number of ships, both steam and motor, and the gross tonnage in each category are tabulated, quarterly, for 15 districts. These are Aberdeen, Barrow, Belfast, Bristol, Glasgow, Greenock, Dundee, Hartlepool, Hull, Leith, Liverpool, Middlesbrough, Newcastle-on-Tyne, Southampton and Sunderland.

The annual summary of merchant ships launched in the world during a calendar year published by *Lloyds Register of Shipping* includes a table showing the number and tonnage of steamships

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and motor ships launched during the year in each of the 15 districts listed above together with figures for "all other districts".

(c) *Building.—The Housing Returns* (and Appendices A) *for England and Wales and for Scotland*, quarterly, provide house-building data for standard regions in considerable detail. Information is given on permanent and temporary housing, conversions and adaptations, requisitioning, etc. Appendices B to the *Housing Returns* consist of house-building particulars for each housing authority in the country.

With regard to factory building the only regularly published figures are to be found in the monthly *Digest of Statistics* and provide details of new factory buildings approved, licensed, under construction and completed, in each of the 7 development areas of Great Britain. Factory building is a topic which appears with fair regularity in parliamentary questioning. Useful regional information is frequently given in reply to questions by Members of Parliament interested in particular areas. The licensing and authorization procedure implies the existence of very comprehensive data on this matter in the Board of Trade but comparatively little is regularly published.

7. *Distribution*

There are two sources of regional information relating to Distribution, the Census and the Board of Trade Retail Trade Statistics.

(i) *Census of Distribution.*—The first Census of Distribution for this country was taken in respect of the year 1950 and when the full report is published we shall have detailed knowledge of all branches of distribution for different areas of the country. The report on the retail and service trades recently published tabulates the value of total sales in each of the many different types of retail business for standard regions, conurbations and towns of over 25,000 population. Total sales in all retail and service trade establishments only is given for smaller towns.

(ii) *Retail Trade Statistics* (*Board of Trade Journal*).—Statistics on retail trade are published monthly in the *Board of Trade Journal.* For each region of the country are presented figures showing the percentage changes in values of sales and of stocks compared with a year earlier for large retailers. The term large retailers denotes department stores, firms operating multiple chains with 10 or more branches, and retail co-operative societies. The basis of the figures is average weekly sales per month and total stocks at cost at the end of the month. Data are given for 10 main groups of merchandise, some of the groups being finely subdivided further into as many as 10 categories.

In addition a table is given each month showing, in the form of monthly index numbers, the values of sales per week by trading areas for large retailers in four main categories of goods.

From the point of view of the industrial prospects of a region the regional trade figures may, of course, be quite inadequate. Cotton goods are not only sold in Lancashire. Thus, it is relevant to point out that

(a) Retail trade figures, similar to those discussed above, but for the country as a whole, are given for department stores, multiple shops, co-operative societies, and independent retailers separately. The first three types form the large retailers group. Independent retailers are shops owned individually or which are members of small chains with less than 10 branches.

(b) Quite separate and distinct statistics are published on sales by and stocks in wholesale textile houses. These are monthly figures for the country as a whole. There is no regional break-down. Data are tabulated for three main categories of merchandise and given in the form of monthly index numbers.

8. *Transport*

It is necessary to supplement what has been said about transport in the section on nationalized industry by covering statistics of shipping movements and road traffic which are outside the scope of any publications relating to the nationalized sector.

(i) *Shipping.*—Quarterly in the *Board of Trade Journal* are presented figures of shipping movements at United Kingdom ports. Foreign trade arrivals and departures at various port areas in the United Kingdom and at the principal parts are tabulated quarterly. Coasting trade statistics are given for the principal ports. The *Board of Trade Journal* also provides quarterly data of sea passenger movements from ports in the United Kingdom to various broad overseas areas.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The shipping figures published in the *Board of Trade Journal* are given only in totals and show no break-down by commodity groups. Each third year, however, the *Annual Statement of Trade of the United Kingdom* includes a supplement showing a full analysis of the imports into and exports from each port of the United Kingdom in the last three calendar years. This most useful publication provides statistics in the usual detail of trade figures in annual statements for every sea port and for airports in aggregate.

(ii) *Road traffic.*—Two important sources need to be referred to here. For other road traffic material reference should be made to the paper "Road and rail statistics", by F. A. A. Menzler, in *J. R. Statist. Soc.* (Ser. A), Vol. CXIII, Part III, 1950.

Firstly, the Ministry of Transport publication—*Mechanically Propelled Road Vehicles in Great Britain*—gives, quarterly, the number of new registrations in each registration and licensing area for the quarter, classified by type of vehicle, and annually, a census of vehicles for which licences were current in each area again classified by vehicle type.

Then, the periodical *Road Traffic Census* provides valuable information on intensity and distribution of road traffic. Road mileage and traffic density in different areas and periods, along various roads and at different points are all measured and tabulated. The latest census, so far available, is for 1950. The previous one was taken in 1938.

9. *Income*

While annual national income and expenditure figures are now accepted as an essential part of economic knowledge regional income figures are only in the embrionic stage. Income and expenditure data for Scotland may be an offspring of the deliberations and recommendations of the Catto Committee on Scottish Financial and Trade Statistics but there has been no official suggestion regarding the provision of regular regional income figures in general. It will be seen below, however, that information has recently become available on the regional distribution of personal incomes which form, of course, a very high proportion of total income. Furthermore, work is in progress on regional social accounts at the Cambridge University Department of Applied Economics and one paper on wage and salary bills has already appeared.

In the absence of comprehensive regional income estimates, here we survey the information available on constituent elements in regional incomes.

(i) *Personal incomes.*—The Income Census taken by the Board of Inland Revenue in respect of the year 1949–50 provided estimates of the total and distribution of personal incomes in different areas of the country. The basis of the estimates was a 10 per cent. sample of all taxpayers. The results were published in the 95 *th Report of the Inland Revenue for the Year Ending* 31*st March*, 1952. The distribution of net personal income before taxation was given for each county showing also the principal sources, wages and salaries, profits and professional earnings, income from property, from which the income was derived. The allocation to counties was by reference to place of assessment which does not necessarily coincide with county of residence. This is of considerable importance in London and the other large conurbations where commonly residents in one county may be assessed in another.

(ii) *Wages and salaries.*—Some of the more important statistics of wages, such as the Ministry of Labour six-monthly earnings figures or of salaries such as the Office Management Association reports, are available only for the country as a whole although clearly it would be feasible for these enquiries to provide regional data. Indeed individual research workers have, from time to time, been supplied with regional material by the organization or department concerned (see, for example, section (c) following). Again, for many trades it may not be too rash to assume that the national average of earnings applies regionally. As detailed regional employment figures are available regional wage bills can be easily computed. However such devices and improvisations will readily suggest themselves and it is appropriate in this paper to concentrate attention on published primary sources.

(a) *Census of Production.*—In the 1948 Census of Production reports on individual trades the regional analysis (Table 5) includes, *inter alia*, wages and salaries in each region of the country except when regional data are not given owing to the danger of disclosing information relating to individual firms. The 1949 reports, however, contain no regional material. While questions have been asked about wages and salaries in all post-war censuses taken so far it is clearly by no means certain that the reports when published will always provide regional analysis.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(b) *Census of Distribution.*—The 1950 Census of Distribution report on the retail and service trades tabulates the total of wages and salaries paid at establishments in each type of retail business for standard regions, conurbations, and towns of over 25,000 population. Totals for all retail and service trade establishments only are given for smaller towns. The full report on the census will provide regional information on wages and salaries for all branches of distribution.

(c) *Other sources.*—Mention has already been made of the work in progress on regional social accounts at the Cambridge University Department of Applied Economics. One paper on wage and salary bills in different industries regionally has already appeared ("Regional variations in United Kingdom incomes from employment, 1948", by Phyllis Deane, *J. R. Statist. Soc.* (Ser. A, Part II, 1953). Miss Deane used largely sources of information already discussed but was granted access to regional break-downs of the Ministry of Labour earnings figures which are only published nationally and to the original material on salaries collected by the Office Management Association.

Finally the publications on nationalized industries mentioned earlier frequently contain regional data on wages and salaries, etc., while, again, national figures would apply regionally in the case of an industry such as cotton, heavily concentrated in a single area of the country.

(iii) *Profits.*—Annual Inland Revenue reports now analyse total trading profits (Schedule D: Profits from Businesses, Professions, etc.) by region. First published in the 93*rd Inland Revenue Report for the Year Ending* 31*st March*, 1950, and relating to assessments made in 1948–49, for each region, gross true income, depreciation allowances, and net true income were tabulated. The allocation of profits to regions was based on the place of assessment, which normally depends on the location of the head office of the business concerned. In consequence the figures for any region may include some profits earned by establishments in other regions. Likewise profits earned in establishments owned by firms with head offices in other regions will be excluded from the profits of the region in which such establishments are situated.

In the 94*th Report for Year Ending* 31*st March*, 1951, slightly fuller data were published for assessments made in 1949–50. Individuals and firms were separated from companies and local authorities. The numbers of assessments, gross true income, depreciation allowances, and net true income in each of the above two categories were tabulated for each region. This is the latest information of this type so far available since the regional break-down of Schedule D assessments was not given in the 95*th Inland Revenue Report.*

Perhaps the most important non-official source of information on profits, *The Economist* quarterly analysis of assets and profits in main industrial groups is not provided regionally. The analyses are relevant, however, and not without regional application in that (*a*) some industries are strongly localized (*b*) there may be little reason why the prosperity of a particular industry in a region should differ materially from that for the whole country. Company reports from which the *Economist* analysis is compiled form a useful source of economic knowledge. Progress in the centralized collection, filing, and analysis of company reports in a region would be most valuable.

10. *Saving*

Direct information about savings is meagre and not very reliable even nationally. Regionally it is almost non-existent. We have no knowledge of business savings regionally. Personal savings through building societies (deposits and mortgage repayments) or industrial and provident societies or savings through life assurance offices are all available only nationally. The only regional savings figures obtainable are as follows:

(i) The National Savings Committee is prepared to provide statistics of small savings in a region comparable with the data published nationally. The categories covered are Savings Certificates, Defence Bonds, Deposits in Post Office Savings Banks and Trustee Savings Banks. These figures are not published regularly but are available on request from the Regional Commissioners of the National Savings Committee.

(ii) Statistics of deposits in individual Trustee Savings Banks are published in the year books of the Trustee Savings Banks Association.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

11. *Banking*

Again, few of the national statistics relating to banking activity are broken-down regionally. For example, the British Bankers' Association publishes quarterly an industrial analysis of bank advances but it is understood that no regional analysis of these figures is feasible. Further, while some of the important banks in this country have head offices in a regional centre, and indeed originated provincially, in most cases their activities extend over a wide area and none of the data for individual banks can be taken to apply to particular regions.

The only regional information available is *Provincial Bank Clearings*. Monthly figures of bank clearings at 12 provincial centres (Birmingham, Bradford, Bristol, Hull, Leeds, Leicester, Liverpool, Manchester, Newcastle, Nottingham, Sheffield and Southampton) are published by the British Bankers' Association. The area of clearance is, however, in each case, very small. In Manchester, for example, the area is that included within a half-mile radius of the Bankers' Clearing House in the centre of Manchester. In other words, that area within which cheques can be cleared by hand. Outside this small area cheques are cleared through London. Another defect is that, of course, the figures relate only to clearings between banks and exclude clearings between branches within banks. Statistics of bank debits would be more useful as economic barometers. Nevertheless the clearings at a metropolitan centre such as Manchester, so important in relation to the predominant industry of the region, do provide a useful indicator of the level of economic activity. Another big advantage is that the data are fairly quickly available. For instance, the latest return, published in the Records and Statistics Supplement to the *Economist* on May 9th, 1953, gave the figures for the month of April, 1953.

VII. Comments and Conclusions

Surveying available regional economic statistics from the conventional angle it is seen that while a fairly comprehensive picture can be drawn there are still important gaps in our information and some less than satisfactory features about the statistics published.

For example, there are very inadequate data on income and saving in regions of the country. It would be very helpful if the Ministry of Labour could be persuaded to break down its wages enquiry results regionally and if the Inland Revenue would publish income assessments under all schedules on a regional basis. Still better, if the National Income and Expenditure figures given in the annual White Paper and Blue Book could be analysed by region. Another useful development would be the provision of estimates of saving through friendly societies, building societies, and life assurance in different areas of the country. Regrettably there would probably be insuperable difficulties (both conceptual and practical) about estimating business savings regionally. Then again, while the regional investment pattern as far as housing, mining and the public utilities are concerned can mostly be pieced together from the sources discussed earlier, we have little knowledge of capital investment by manufacturing industry in regions of the country. Even the 1948 *Census of Production* reports gave only national figures on capital expenditure by the various industries.

Moreover there are statistics unavailable, even nationally, the lack of which is more seriously appreciated when regional economics is being considered. Reliable and comprehensive figures of stock movements, statistics of order-books in the more important industries, bank debits, are just a few of the serious lacunae in our economic knowledge. National figures here would help enormously, regional data would be even more welcome.

It is also necessary seriously to question the desirability of attempting to force virtually all sub-area information into the mould of the standard regions. There are two aspects of this. In the first place, standard regions may be quite inappropriate for certain types of data. We have seen that when technical considerations enter, as in the nationalized sector, different areas emerge. Lack of uniformity in areas limits, of course, the extent to which different types of statistics can be collated but this may be the inevitable cost of providing certain figures for the most appropriate territories. Secondly the regional structure, standard or otherwise, which has been the basis adopted for provision of information hitherto has been determined largely from the viewpoint of administrative convenience. The regions have usually been much larger than would be the case if economic homogeneity had been the criterion. Thus from the purely

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

economic point of view much smaller areas may be desirable. One move in this direction already made is the publication in the 1951 *Population Census* and 1950 *Distribution Census* reports of statistics for conurbations, the largely built-up areas surrounding the great towns of London, Birmingham, Liverpool, Manchester, Newcastle and Leeds-Bradford.

While gaps in knowledge are regrettable enough, it is probably even more unfortunate that the existing statistics which are published must be criticized on certain counts. There is frequently very considerable delay in publication. The last report on the 1948 *Census of Production* was available only in March, 1953. *Tables relating to employment and unemployment*, giving a regional and industrial analysis of employment and unemployment, have not been published since those relating to mid-1950. Then again some of the statistics are subject to wide margins of error. It became clear during the recent textile recession that in the unemployment figures the temporarily-stopped category included many who were strictly workers on short-time. It also seems likely that the monthly employment statistics for, say, the cotton industry, being based on direct employment returns were in error owing to the practice of some employers in returning workers temporarily stopped as being employed. Appreciable discrepancies between Ministry of Labour employment figures and those in the 1951 *Census of Population* came to light when the 1 per cent sample tables of the Census were published.

However, in using regional economic statistics probably the most serious handicap is the lack of co-ordination in their collection, presentation, and publication. It has been seen that regional economic information is scattered over a wide range of publications emanating from many different departments or organizations. There is no institution in other regions, analogous to the Scottish Office, which could undertake the publication of digests or surveys collecting together in one volume for convenient use the important economic data relating to a particular region.

Most of these comments have been concerned with information of the presently available conventional type. Further development of techniques for the planning and implementation of full employment and distribution of industry policy may necessitate a new type of analysis and corresponding statistical data. It may be necessary to tackle questions which would be very difficult to answer on the basis of existing knowledge. What would be the effect on Lancashire say, if, next year, imports of a particular commodity were cut? What would be the influence on regional economics of a particular type of investment? What would be the implications of a given increase in exports?

The need, then, for regional economic analysis of a quite different type is seen:

(*a*) The construction of regional social accounts.
(*b*) Inter-regional and intra-regional input-output analysis.

By these means the inter-relations between different parts of the economic system can be studied and a rigorous analysis carried out. This approach is in its infancy, particularly on this side of the Atlantic. However, the statistical data at present available on regions of the country would naturally form a basis for the collection of new material needed and the development of these techniques. Some of the new data may have to be collected on a sample basis, perhaps by private investigators. Examples are some of the transactions which would enter into a system of social accounts or production coefficients in regional industry. Much of it, however, would necessarily form part of Censuses of Production or Distribution and clearly could not be contemplated annually. This would, of course, not be essential. Indeed the Board of Trade has already realized that full annual Censuses of Production are a luxury which we can neither afford nor do we need. Since 1948 there has been a gradual diminution in the scale of the Census, both as regards collection of material and publication. While this was no doubt inevitable it is regrettable that regional tabulations have been one of the first casualties in this process.

VIII. BIBLIOGRAPHY

Current Regional Economic Surveys

1. Council for Wales and Monmouthshire (1950): *Report on Activities*; Cmd. 8060.
2. Scottish Office (Twice a year; April, 1953, onwards): *Digest of Scottish Statistics.*
3. Scottish Office (1947 onwards): *Industry and Employment in Scotland: Annual White Papers;* Cmd. 7125, 7459, 7676, 7937, 8223, 8521, 8797.
4. Wales and Monmouthshire (1946 onwards): *Annual Reports of Government Action*; Cmd. 6938, 7267, 7532, 7820, 8062, 8385, 8678.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Individual ad hoc *Regional Reports*

1. Board of Trade (1932): *Industrial Surveys of Merseyside, Lancashire Area, North-East Coast Area, South-West Scotland, South Wales.*
2. Board of Trade (1948): *Distribution of Industry*; Cmd. 7540.
3. British Association: Economics and Statistics Section (1935): *Britain in Depression.*
4. British Association: Economics and Statistics Section (1938): *Britain in Recovery.*
5. Commissioner for Special Areas (pre-war; 1935 onwards): *Reports.*
6. DAYSH, G. H. J. (1938): *West Cumberland, a Survey of Industrial Facilities.*
7. DAYSH, G. H. J. and SYMONDS, J. S. (1953): *West Durham, a Problem Area in N.E. England.*
8. DENNISON, S. R. (1939): *Location of Industry and the Depressed Areas.*
9. FOGARTY, M. P. (1945): *Prospects of Industrial Areas of Great Britain.*
10. Industrial Development Associations (e.g., Lancashire and Merseyside; North-East): *Reports.*
11. JEWKES, J., and WINTERBOTTOM, A. (1933): *An Industrial Survey of Cumberland and Furness.*
12. Manchester University Economics Research Section (1936): *Re-adjustment in Lancashire.*
13. RICHARDSON, J. H. (1936): *Industrial Employment and Unemployment in West Yorkshire.*
14. Royal Commission on Distribution of Industrial Population (1940): *Report.*
15. SMITH, D. H. (1933): *Industries of Greater London.*
16. SMITH, W. (1942): *The Distribution of Population and the Location of Industry on Merseyside.*

Industrial Surveys.

1. ALLEN, G. C. (1951): *British Industries and their Organisation.*
2. Anglo-American Productivity Council: *Reports on Various Industries.*
3. Board of Trade: *Working Party Reports on Various Industries.*
4. COMPTON, M., and BOLT, E. H. (1940): *British Industry.*
5. JONES, G. T. (1933): *Increasing Returns.*
6. Monopolies Commission: Various reports.
7. Political and Economic Planning: Reports: *Cotton* (1934); *Electricity Supply* (1936); *Gas* (1939); *Fuel and Power* (1947); *Agricultural Machinery* (1949); *Motor Vehicles* (1950).
8. SILVERMAN, H. A. (Editor) (1946): *Studies in Industrial Organisation.*

Cotton Industry

1. Board of Trade (1946): *Working Party Reports on Cotton.*
2. Cotton Board (1946 onwards): *Quarterly Statistical Review.*
3. THOMAS SKINNER AND CO. LTD. (Manchester) (Annually, 1923 onwards): *Cotton Trade Directory of the World.*
4. JOHN WORRALL, LTD. (Oldham) (Annually, 1882 onwards): *The Lancashire Textile Industry.*

Wool Industry

1. Board of Trade (1947): *Working Party Report on Wool.*
2. International Wool Secretariat (Fortnightly, January, 1950, onwards): *World Wool Digest.*
3. Wool Industry Bureau (November, 1949, onwards): *Monthly Summary of Statistics.*
4. John Worrall, Ltd. (Oldham) (Annually, 1882 onwards): *The Yorkshire Textile Industry.*

Nationalized Industries

1. British Electricity Authority and Area Electricity Boards (Annually, 1947/9 onwards): *Reports.*
2. British European Airways Corporation (Annually, 1947/8 onwards): *Reports.*
3. British Transport Commission (Annually, 1948 onwards): *Reports.*
4. Gas Council and Area Gas Boards (Annually, 1948/50 onwards): *Reports.*
5. Ministry of Civil Aviation (Annually, 1946 onwards): *Reports.*
6. Ministry of Fuel and Power (Annually, 1938/44 onwards): *Statistical Digest.*
7. Ministry of Fuel and Power (Weekly, Sept. 9th, 1947, onwards): *Statistical Statement.*
8. Ministry of Fuel and Power (Annually, 1911 onwards): *List of Mines.*
9. National Coal Board (Annually, 1946 onwards): *Reports.*
10. National Coal Board (Monthly): *Coal Figures.*
11. National Coal Board (Quarterly): *Statistical Statement on Costs, Proceeds, and Profit or Loss.*

Agriculture

1. Department of Agriculture for Scotland (Annually): *Agricultural Statistics for Scotland*: Parts I and II.
2. Ministry of Agriculture and Fisheries (Annually): *Agricultural Statistics for England & Wales*: Parts I and II.
3. Ministry of Agriculture and Fisheries (1946): *National Farm Survey.*

Regional Economic Statistics in General

Demography

1. General Register Office: 1951 *Population Census; Preliminary Report for England and Wales.*
2. General Registry Office, Scotland: 1951 *Population Census; Preliminary Report for Scotland.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3. General Register Office and General Registry Office, Scotland: 1951 *Population Census: One per cent. sample tables*: Parts I and II.
4. General Register Office and General Registry Office, Scotland: *Weekly Returns of Births and Deaths.*
5. General Register Office and General Registry Office, Scotland: *Quarterly Returns of Births, Marriages and Deaths.*
6. General Register Office and General Registry Office, Scotland (Annually): *Estimates of Local Populations.*
7. General Register Office and General Registry Office, Scotland (Annually): *Statistical Review.*

Labour

1. Ministry of Labour (Annually, 1946 onwards): *Tables Relating to Employment and Unemployment.*

Factories

1. Ministry of Labour (Annually): *Reports of Chief Inspector of Factories.*

Production

1. Board of Trade (1935 and annually, 1948 onwards): *Census of Production Reports.*
2. Iron and Steel Federation (Monthly): *Statistical Bulletin.*
3. Iron and Steel Federation (Annually): *Statistical Year Book for the U.K.*
4. Lloyds Register (Quarterly, 1930 onwards): *Shipbuilding returns.*
5. Ministry of Housing and Local Government (Quarterly, 1946 onwards): *Housing Returns.*

Distribution

1. Board of Trade (1950): Census of Distribution: *Short report on the retail trade.*
2. Board of Trade (1950): Census of Distribution: Vol. I. *Retail and Service Trades; Area Tables.*
3. Cecil Chisholm (Editor) (1936, 1948, 1951): *Marketing Survey of the U.K.* Business Publications, Ltd.

Transport

1. Ministry of Transport (Monthly, Quarterly and Annually; 1927 onwards): *Mechanically Propelled Road Vehicles in Great Britain.*
2. Ministry of Transport (1950): *Road Traffic Census.*

Income

1. Commissioners of Inland Revenue (Annually, 1849 onwards): *Reports.*
2. DEANE, PHYLLIS (1953): "Regional variations in U.K. incomes from employment", *J. R. Statist. Soc.*, A, Part IV.
3. Office Management Association (Annually, 1946 onwards): *Clerical Salaries Analysis.*

General & Miscellaneous

1. *Board of Trade Journal*: Fortnightly.
2. Central Statistical Office (Annually): *Abstract of Statistics.*
3. Central Statistical Office (Monthly): *Statistical Digest.*
4. *Ministry of Labour Gazette*: Monthly.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CONTENTS

	PAGE
1.—*Walker* (*Helen M.*) & *Lev* (*Joseph*). Statistical Inference	102
2.—*Kuhn* (*H. W.*) & *Tucker* (*A. W.*). Contributions to the Theory of Games. Vol. II	103
3.—*Jackson* (*Willis*) (Ed.). Communication Theory	104
4.—*Lindquist* (*E. F.*). Design and Analysis of Experiments in Psychology and Education	105
5.—*Bowden* (*B. V.*). Faster than Thought	106
6.—*Spear* (*Mary E.*). Charting Statistics	107
7.—*Paradine* (*C. G.*) & *Rivett* (*B. H. P.*). Statistics for Technologists	107
8.—*Mothes* (*J.*). Techniques modernes de contrôle des fabrications. Tome I	108
9.—National Bureau of Standards. Applied Mathematics Series. Tables of Normal Probability Functions; Probability Tables for the Analysis of Extreme-Value Data	109
10.—*Lindley* (*D. V.*) & *Miller* (*J. C. P.*). Cambridge Elementary Statistical Tables	110
11.—*Frankel* (*S. H.*). The Economic Impact on Under-developed Societies	111
12.—*Mills* (*F. C.*). Productivity and Economic Progress	112
13.—*Woytinsky* (*W. S.*) & *Woytinsky* (*E. S.*). World Population and Production	112
14.—*Winkler* (*W.*). Typenlehre der Demographie	114
15.—International Association for Research in Income and Wealth. Income and Wealth. Series II. Edited by Simon Kuznets; Income and Wealth, Series III. Edited by Milton Gilbert	114
16.—Economic Co-operation Administration. The Sterling Area: an American Analysis. Prepared under the direction of John M. Cassels	116
17.—*Desai* (*R. C.*). Standard of Living in India and Pakistan, 1931–32 to 1940–41	117

1.—*Statistical Inference*. By Helen M. Walker and Joseph Lev. New York: Henry Holt and Company, 1953. xi + 510 pp. $9\frac{1}{2}''$. $6.

This is a book on statistical methods for non-mathematicians. The chapter headings, with explanations in parentheses, are the following. Inferences based on simple experiments (7 pages, containing a very simple example of an inference procedure): Probability distributions (35 pages giving the elementary probability rules and discussing the binomial distribution and the normal limit): Inferences concerning proportions (38 pages, including the concept of power): Chi-square (28): Populations and samples on a continuous variable (15): Sampling distributions (19 pages, being a description of a sampling experiment from a normal distribution and illustrating the t-, χ^2- and F-distributions): Inferences concerning the mean or the difference between two means (36 pages, normal theory): Inferences concerning variances and standard deviations of normal populations (17): Analysis of variance (34): Linear regression and correlation (31): Other measures of relationship (28 pages for biserial, point biserial, phi, tetrachoric and rank coefficients and the correlation ratio): The statistics of measurement (26 pages on the reliability of test procedures): Multiple regression and correlation (33): Analysis of variance with two or more variables of classification (39 pages, both models): Analysis of covariance (26): Percentiles (10 pages of some useful inefficient statistics): Transformation of scales (a mere 3 pages): and finally Non-parametric methods in 25 pages (this chapter is written by Lincoln Moses).

There are 32 pages of tables and charts in the appendix, beginning with a most unsatisfactory table of areas under the normal curve in which the first column entries are the negative of those in the second, the fourth are one minus those in the third, and the fifth are twice those in the third, and for which interpolation is almost impossible. The tables have presumably been produced by a photographic process since there is considerable variation in the type. Why do authors include tables in a book, a most inconvenient form for computational purposes? There is also a Glossary of Symbols, a set of answers to the problems in the text ("additional exercises and review questions will be provided by the publishers at nominal cost"), and indexes of subject matter and authors.

The senior author is Professor of Education at the Teachers' College, Columbia University. This fact is reflected in the choice of examples, practically every one of which relates to educational experiments such as test procedures, comparison of different teaching methods or judgments of intelligence. The result is dull reading for any one not interested in these subjects. Moreover, since the instructional method employed in the book is to explain each technique through an example rather than to illustrate by an example, the relevance of the techniques to other fields of study is not apparent. Nor is it always clear what features of the example are peculiar to it and which are

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

part of the general technique under study. On the other hand the educationist interested in acquiring some statistical knowledge will probably find the treatment satisfactory; the problems that he encounters, or recognizably similar ones, will be found here.

There are no proofs, though mathematical symbolism is used extensively and carefully explained. The reader is assumed to have done a short course in statistics before, and to be familiar with ideas such as mean, standard deviation and linear regression. It would have been helpful to have indicated precisely what is supposed to be known.

There are, on the statistical side, numerous statements which are either wrong or misleading. A few examples will suffice. "If a variable can take only a finite set of values it is called *discrete*" (p. 8). (The Poisson distribution occupies only six lines on p. 424.) "A hypothesis which states that the difference between two parameters is zero is called the *null* hypothesis " (p. 77). "In order that the t ratio shall have 'Student's' distribution the numerator must be a normally distributed variable with mean zero and the denominator must be the square root of a variable which is distributed as χ^2 independently of the numerator" (p. 135). "The Central Limit Theorem . . . states that for a wide variety of populations statistics based on large random samples are distributed normally" (p. 143). "Certain . . . statistics are known to be efficient . . . among . . . these are maximum likelihood statistics" (p. 415). "Most of the statistics which have been studied . . . as the . . . variance . . . are maximum likelihood statistics" (p. 415).

But my main objection to the book is that in its explanation through examples and in its persistent repetition of formulae in slightly varying forms, as though formulae were the magic tools, the essential statistical concepts are obscured. This is not always true by any means—the introductory chapters explain confidence limits satisfactorily—but in general it is. For example the chapter on multiple regression is a mass of complicated formulae, based on outdated methods, which completely succeed in obscuring the issue. Students, in the reviewer's experience, do not find it particularly difficult to do, say, an analysis of variance of a simple type, but they do find it difficult to understand just what they are doing and why, and to recognize a situation that can be analyzed by that technique when it occurs in practice. The present book does not help here.

The balance of material is somewhat surprising, too. The idea of power is explained at length (and very well, too) but the more important idea of efficiency is skimped. Correlation coefficients of all types are discussed but least squares techniques are very briefly mentioned. Analyses of variances are ably dealt with and the two models are carefully distinguished but there is hardly any mention of the importance of randomization. (On one occasion (p. 10) the text "always randomize" is treated as an eleventh commandment without clearly saying why this should be so.)

The book should be of value to educationalists interested in the application of statistical methods, but there are better books for other students.

D. V. LINDLEY.

2.—*Contributions to the Theory of Games.* Volume II. Edited by H. W. Kuhn and A. W. Tucker. Princeton Univ. Press (London: Geoffrey Cumberlege), 1953. viii + 395 pp. 10″. 25*s*.

Volume I of the same title appeared in 1950 and was reviewed in this *Journal* (**94**, p. 577, 1951). It contained 201 pages, and it is a remarkable indication of the vigour of the subject that a second volume of the *Annals of Mathematics Studies* could appear so shortly afterwards, with almost twice that number of pages. The editors are the same as before, and so are some of the contributors. The Introduction states that some of the problems mentioned as unsolved in the Preface of the earlier volume are now solved in the present one.

Volume II consists of four Parts, headed: Finite zero-sum two-person games; Infinite zero-sum two-person games; Games in extensive form; General n-person games. These titles show in which directions the relatively simple theory contained in the classical book by von Neumann and Morgenstern is being developed.

The Preface of Volume I listed as one of the outstanding problems: "to find a computational technique of general applicability for finite zero-sum two-person games with large numbers of pure strategies." This is still one of the most important aims. Of course, there can never be a final answer to a problem of computation, as there cannot be to an engineering problem. Thus the search goes on for methods, some of which are generally applicable while others refer only to selected classes of games. Research is assisted by transforming games into other, seemingly unrelated ones, the solution of which is equivalent to that of the game originally considered. Also, the exhibition of solutions to simplified versions of such complicated games as, say, Poker is useful in this context.

When the sets of available pure strategies are infinite, one is tempted to prove theorems analogous to those for finite games. But it turns out that infinite games exhibit so many pathological features that one must study special types of games first.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The title of Part III refers to the description of games as a succession of moves by the players. This aspect has been largely neglected through the almost exclusive study of games in their normalized form, i.e., as patterns of pay-offs dependent on the respective strategies of the players. However, the consideration of possible patterns of moves led to such interesting results as von Neumann's theorem that every zero-sum two-person game with "perfect information" has a saddle point in pure strategies, and more recent investigations are concerned with the effect of various types of information patterns, that is the knowledge which a player has of earlier moves made either by himself or by his opponent(s).

Another unsolved problem mentioned in the first volume was that of a solution for a general n-person game. It is still unknown whether such a game always has a solution in the sense of von Neumann and Morgenstern, and one may therefore either study special cases for which this existence can be proved, or one may try to change the definition of a "solution". It would appear that for the economist it is precisely the n-person game which relates to his most pertinent problems. For this reason, one feels that the freedom of the mathematician to choose his definitions as he pleases has its drawbacks. He would be unwise to denote as a solution a situation which the economist would never accept as a goal worth attaining, or indeed attainable. The difficulty is that of constructing a model of economic behaviour which is recognized as being realistic. Hence the various new models of co-operative and non-co-operative games, and also the stimulating or exasperating—according to your mood—evasiveness of the subject.

Within the field of mathematical convention all 21 papers are, of course, unassailable. But the reader will be allowed a heretical grumble. Must everything be expressed in the most extreme abstract terms? Must the reader first learn a new vocabulary, to understand relations which must then be re-translated into more homely terms? This was done for him, incidentally, in a textbook by McKinsey, which appeared in 1952 and had already referred to results which are now exhaustively presented in the book under review.

The short time lag between the two books of the same title has been mentioned as a proof of the liveliness of the subject. Further demonstration, if required, is contained in the bibliography which lists well over 100 items and is already out of date. S. VAJDA.

3.—*Communication Theory* . . . Edited by Willis Jackson. London: Butterworth, 1953. xii + 532 pp. $9\frac{3}{4}''$. 65*s*.

This volume is a record of the Proceedings of a Symposium on Applications of Communication Theory held in September, 1952. As noted by the editor in his opening address, the Symposium was a sequel to one held in 1950 on Information Theory. It is perhaps a pity that the Proceedings of this first Symposium were never printed, but merely circulated in mimeographed form by the Ministry of Supply; copies have, however, now been made more widely available by being reissued by the Institute of Radio Engineers, New York ($6.75 to non-members). The second Symposium was intended to concentrate more particularly on the practical value of communication theory in the field of electrical communication, and the present volume thus contains an imposing collection of some 38 papers, most of which are somewhat technical in character and devoted to various problems arising in or associated with this field. This is indicated by the titles of the sections:

Transmission systems and coding (9 papers); Transmission in the presence of noise—signal discrimination (8 papers); Characteristics of transmission channels (4 papers); Application to television (3 papers); Hearing (1 paper); Transmission and analysis of speech (8 papers); Associated studies (4 papers).

To readers of this *Journal* not familiar with the information and communication theory discussed at these two Symposia it might be added that it rests in part on recently developed statistical concepts and ideas that all those interested in statistical theory should take note of. The volume under review is hardly to be recommended as an introduction to the subject for such readers; they would do better to read Shannon's original papers or their republication in *The Mathematical Theory of Communication*, by Shannon and Weaver (Urbana, 1949). There is, however, an introductory summary of communication theory by Gabor in the volume under review, which provides a useful "reviver" course on the subject before the plunge into the further technical problems.

It would be impossible to refer here in detail to all the papers, even if the reviewer were competent to do so. Their technical character makes them somewhat indigestible at a first reading, except to the expert, but there is much fascinating material for the information and communication theory enthusiast. Statisticians will be interested not least in the noise-signal discrimination section, especially in paper No. 18 by D. Middleton on "Statistical methods for the detection of pulsed radar in noise". They will find discussed in this paper a discrimination problem between the null hypothesis (noise only) and the alternative (noise plus signal) which will cover familiar ground. Three methods are listed:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(i) the Neyman-Pearson procedure of fixing α, the risk of error if the null hypothesis is true, and minimizing (for a given amount of data n) β, the risk of error if the alternative hypothesis is true;

(ii) minimizing $\alpha + \beta$ for given n (this is labelled, somewhat debatably, as the procedure of an Ideal observer—it corresponds to the decision rule with minimum error risk if the *a priori* probability of a signal is $\frac{1}{2}$);

(iii) fixing α and β and increasing n (the sequential method).

It is the opinion of the reviewer, as he indicated at the 1950 Symposium (both in his own paper and in the discussion following a paper by P. M. Woodward), that such problems of statistical inference should be logically separated from the communication theory problems of the type falling within the scope of Shannon's theory. However, their discussion at the 1952 Symposium stresses all the more the absence of statisticians at the Symposium. The Chairman recently remarked to the reviewer that if he had known in advance that some of the papers being presented were including such material, he would have made sure that invitations to statisticians were sent. I. J. Good, whose name appears from time to time in the discussion on the papers, was apparently the only participant with a foot in the statistical camp. Incidentally, the printed discussions are often very sketchy, but this is perhaps not unexpected with so much material to be got through in the actual papers. The concluding discussion is rather more coherent and represents an attempt to survey the Symposium papers as a whole.

The four papers in the last section, Associated Studies, just before the concluding discussion, seem rather anomalous and fit less with the present technical Symposium than with the first Symposium on Information Theory. They constitute, however, a further interesting reminder of the wide applicability and relevance of the latter theory, especially if it is regarded in its broadest sense, so that particular developments such as communication theory, or R. A. Fisher's theory of information, become classified within it.

M. S. BARTLETT.

4.—*Design and Analysis of Experiments in Psychology and Education.* By E. F Lindquist. Boston: Houghton Mifflin, 1953. xix+393. 9½″. $6.50.

Professor Lindquist has followed his earlier statistical textbooks for students of psychology or education by an introduction to experimental design, with illustrations and jargon from the two fields of application.

After some introductory matter, more than 200 pages of the book are devoted to simple randomized and factorial designs. Latin and Graeco-Latin Squares are then dismissed in 8 pages, the main effects being allegedly confounded with interactions. But this "confounding" is of course taken care of by the randomization. The same point is missed in a longer, but badly organized, chapter on so-called "mixed" designs, in some of which the *same* Latin Square (Latin Square being happily resuscitated) would be replicated. Other designs in this chapter are of the split-plot kind, but there is no explicit treatment of confounding, and no hint of incomplete blocks. The book concludes with isolated chapters concerned with the analysis of covariance and the analysis of trends (in factorial designs), and with a rather complicated-looking discussion of components of variance, set out in terms of the psychometricians' reliability theory.

The relative newcomer, for whom the book was written, may at times be misled by it. The treatment of sampling, for instance, is uneven, as shown by the repeated suggestion that if the given readings are not a random sample, a population of readings "like" the ones observed should be hypothesized, to enable the latters' "significance" to be tested. Tests of significance generally are overemphasized, to the exclusion of estimation or description.

More important perhaps than occasional mistakes or the like, is that the book is, in the author's own words, somewhat verbose, repetitive, and relatively difficult to read. The cause is supposed to be an explicit aim "to develop genuine *understanding* of the *basic principles*". But the effect of repeatedly developing essentially the same (factorial) design is, in fact, that of the rejected "cook-book", as is also the unacknowledged change from the traditional language of plots and blocks, and the omission of references for further reading. Again, already on page 1 the student will find the bald statement that in "most experiments the observed 'effect' is described in terms of the mean value". Should he not be given reasons, so that he might "understand", and be able to deal with such ideas as so-called "true" scores and "average" persons (used by Lindquist himself), and with skew data and transformations? In any case, the analysis-of-variance (or analysis of means) approach does not amount to "experimental design and analysis", especially not in psychology and education, where the correlational approach in particular is still a popular alternative. Some chapters on the wider issues from an experienced writer like Lindquist would have been stimulating.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A point which may be of interest to statisticians is a detailed report (rather out of place in the book as such) of a fairly reassuring empirical study of the effects of variance-heterogeneity and non-normality on the F-distributions. A. S. C. EHRENBERG.

5.—*Faster than Thought.* A Symposium on Digital Computing Machines. Edited by B. V. Bowden. London: Pitman, 1953. xix + 416 pp. 9″. 35*s*.

The rapid advance in automatic electronic computing machinery since the end of the Second World War has fired alike the imagination of the scientific world and the public at large. In fact, imaginations have run riot and a host of misconceptions about the power of these machines have arisen and there has been an immense amount of idle chatter about "mechanical brains", the immediate "abolition of mental drudgery", "universal translating machines" and the like.

In the light of this state of affairs, a book which summarizes the stage of development of this new field of scientific activity is long overdue. The difficulties of writing such a book are illustrated by the history of the book *Faster than Thought*. This was started early in 1951 as a pamphlet to be issued at the time of the Festival of Britain and by 1953 alterations were still being made as the print was being set.

As the editor remarks, any book on this rapidly developing subject is bound to be out of date before it is published.

Because of this rapid development, the publishers have been very wise to arrange the book as a collection of chapters by different authors. Any one author who knew sufficient of the subject to write a book of this size would be taking an active part in its development and would, in all probability, albeit unconsciously, present a one-sided account. Their wisdom has been matched by their good fortune in securing an editor who has most skilfully welded together the various articles to produce a unified account of the subject embracing all its aspects without a patchwork effect and, more remarkable still, with hardly any duplication of material.

The book consists of three parts, the first an introduction, the second a set of accounts of existing machines and the third and longest part concerned with applications of the machines.

The first part, written mostly by Dr. Bowden himself, contains a history of computation which gives a full account of the work of Babbage. It is clear that Dr. Bowden has done a great deal of historical research into Babbage's work and, like all who have studied his ideas, is full of enthusiasm for the genius of that much misunderstood man. This enthusiasm carries him away into accounts of Babbage's life, that of Lady Lovelace (who translated an account of his projected machine) and those of her husband and daughter. Although these pages are written in a witty style that the reader soon learns to recognize as characteristically Bowden, and form delightful reading, the space might have been better spent on some of the achievements of others in building computing machinery.

After this biographical interlude, an analysis of the components required for automatic machines is made and various material realizations of these components described. The organization of these components into a working machine is discussed in the next chapter and is followed by a chapter about practical matters such as valve-life and reliability. The first part closes with a short account of programming for these machines which succeeds in bringing out the basic difficulties of that art.

To all but experts in the field, the second part of the book is rather dull and inevitably tends to be repetitive. However, to the expert the section is a gold mine as it contains information about various machines which in some cases does not exist in print anywhere else. The tenacity with which Dr. Bowden and his colleagues must have hounded some of the designers and builders of machines to persuade them to give accounts of their machines is past praise.

It is the third part of the book which deals with the most controversial aspects of the subject. First, the use of the machines to solve logical problems is explained and a history of previous special machines that have been built for this application is given.

Then there are rather less exciting chapters on the applications to crystallography, meteorology, ballistics and engineering. These, by their solid matter-of-fact approach, are far more convincing that these machines will rapidly revolutionize almost all branches of science and technology than the usual vague generalizations about "brains".

Three further chapters deal with the role of these machines in government administration, business and commerce and in economics.

There is a chapter on how to use machines to play games which gives a salutary jolt to those who have failed so far to realize the limitations of machines. This chapter acts as an excellent introduction to the final chapter on "Thought and Thought Processes". This shows clearly that in certain senses of that word no machine can "think" but, and here we can be sure it is Dr. Bowden writing, that the same tests applied to most human beings would show that they cannot think either.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

For a thoroughly entertaining and balanced account of this new art, craft and science, *Faster than Thought* is to be recommended. May I add that I write this, not because I wrote one small chapter of four pages of the book, but because it is really true. K. D. TOCHER.

6.—*Charting Statistics.* By Mary E. Spear. McGraw-Hill Book Co. Inc., 1952. xii + 235 pp. 38*s.* 6*d.*

This book on graphs, charts and diagrams, is based on experience gained in analysing and presenting statistics for Government Departments and other organizations in the United States. It is generally sound, is not ostentatious and contains many practical hints, such as those about the labelling and spacing of diagrams. There is warning against making charts attractive to the eye at the cost of clarity in exposition. There is discussion on the optical illusions that sometimes arise as a result of shading and other additions to simple charts and of the misleading effects that can be obtained by using a base line which is not a natural zero, by breaks in scale, and by unsuitable scales.

After marking scripts in which students were asked to suggest improvements to the *Monthly Digest of Statistics* the reviewer knows how great is the demand for columns of figures to be supplemented by charts, yet in practice he is convinced that charts can usefully show only simple relationships and trends. If attempts are made to illustrate the more complex, but often important, features of figures the diagrams often become difficult to interpret. For instance, as soon as columns or bars are divided into sections, even if only into two, to show, perhaps males and females as well as totals, they immediately fail to compare satisfactorily one of the three aspects, for instance the number of high school boys who graduated, illustrated in the diagram on p. 126. Yet this is a simple diagram, not even requiring a separate key as the more complex diagram on the following page does, which shows satisfactorily little but aggregate new construction expenditures and the public proportion thereof, both of which are represented from the same horizontal base line. To get a clear impression of the relationships between the other items one needs a rule and a pencil to jot down the measurements—in other words one needs to construct a table. Additions to simple charts can easily make them into what might be called "waiting room specimens", the primary purpose of which is presumably to provide an interesting task in seeking a solution before the time for an interview. One of these charts, a "column chart with pictorial display", illustrates the cost of a typical thanksgiving dinner in 1948 and 1949, where first impressions would lead one to expect the sum of the individual costs of turkey, potatoes, etc., to be the total cost, but this is not so. The lengths of the individual blocks represent costs of arbitrary units which have no relation to the quantities of the commodities likely to be consumed in the typical dinner.

Throughout the book one has the feeling that the author has been struggling with a desire to use only good and simple charts and yet was required to fill 150 pages without obvious repetition. The struggle has not been entirely successful. The chapter on line charts which deals with graphs is followed by one on surface charts which are graphs with the area under the line shaded; the chapter on column charts is followed by one on bar charts which are column charts with the columns horizontal. These four chapters constitute over half the book, the remainder consists of chapters on planning the chart, on map charts, on "other types" including pie charts and those with pictorial symbols, on exhibits and on duplicating and colour. The treatment has been on the presentation of statistics diagrammatically and one doubts if there was sufficient to say on the subject to fill this book. Yet, whilst still keeping within the definition of "charting statstics" it would have been possible to add sections on a very different aspect of statistics, that is on charts as working instruments. Moving averages and the fitting of algebraic trend lines might have been included as aids in looking for changes in trend and deviations from trend. The cumulative diagram might have been dealt with as a means of estimating the median, quartiles and deciles. Normal curves with the same mean and standard deviation might have been drawn in the same diagrams as actual distributions to show relationships, and industrial control charts could have been illustrated.

This is a good book, rather longer than is necessary to cover the ground it sets out to cover but which might usefully be made to cover rather more ground. H. S. BOOKER.

7.—*Statistics for Technologists.* By C. G. Paradine and B. H. P. Rivett. London: English Universities Press, 1953. vii + 288 pp. 8½″. 25*s.*

Mr. Paradine and Mr. Rivett have written an introduction to statistical methods and theory for engineers and technologists. The balance of theory and methodology is typical of books on applied mathematics for engineers; proofs are given in full when they involve only elementary algebra and calculus, some proofs requiring more advanced mathematics are given but may be omitted without disturbing the continuity of the book, while topics requiring elaborate mathematical treatment are discussed without proof. There are many worked examples in the text and an excellent collection of exercises for the student. The exercises are nearly all numerical rather than

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

mathematical, some being taken from examinations, such as that for the R.S.S. Certificate, and others from industrial applications.

The book starts with the general description of frequency distributions and ends with an account of the simpler forms of analysis of variance and the method of maximum likelihood.

The general plan of the book is good, it is well-written and it is designed to meet a real need for a moderately mathematical account of modern statistical ideas. Unfortunately, however, there are a number of details which are open to criticism. The following are examples.

The notation for estimates of variance is ill-chosen. Before the distinction between populations and samples has been explained, σ^2 is used for the variance of both, dividing the corrected sum of squares by the number of individuals, n. Later s^2 denotes the estimate from a sample, dividing by n, and σ^2_e the estimate dividing by $n - 1$. Later still, σ^2 is used simultaneously for the population variance and for the estimate previously denoted by σ^2_e.

In Chapter XIII the justification for the method of maximum likelihood is stated to be that it gives estimates that are asymptotically unbiased, no mention being made of the asymptotically-minimum-variance property. More serious from a practical point of view is the omission of the formula for the variance of a maximum likelihood estimate, even in the discussion of the application to probit analysis.

The chapters on the theory of errors and the method of least squares seem to be in a different style from the rest of the book and might well be rewritten when a second edition is prepared. The chapter on the theory of errors starts with a badly phrased derivation of the normal law from the principle that "the mean is the most probable value." This derivation is supposed to provide a reason for expecting to find the normal distribution in practice; the justification from the central limit theorem is not mentioned in this chapter. Gauss's theorem that the method of least squares gives linear unbiased estimates of minimum variance is not referred to, and no convincing justification of the method of least squares is mentioned. In this and the following chapter on correlation only a very brief account is given of the choice of dependent and independent variables in regression analysis, nor is the difference in outlook between regression analysis and correlation analysis made clear.

Despite these points, the book can be recommended, particularly to students. To work through the book doing a fair proportion of the exercises would be a very good introduction to statistics.

D. R. Cox.

8.—*Techniques modernes de contrôle des fabrications.* Tome 1. Les applications classiques de la statistique à la recherche et au contrôle industriels. By J. Mothes. Paris: Dunod, 1952. 547 pp. $9\frac{3}{4}''$. Bound. 140*s*.

This book, typically French in its thoroughness and in its approach to the subject, contains all that an industrial scientist entrusted with the control of quality of production would need to know about statistical methods. Some would say, more than he needs to know, for this volume is more mathematical than most. For example the following appear: the geometrical derivation of the χ^2 distribution; the derivation of the moments of the log-normal distribution; the equations and criteria for classifying the Pearson type curves. And this although a companion volume is planned, by another author working in close collaboration with the present one, to deal with the theory and with the more recent applications of statistical methods to industrial problems. Undoubtedly this is the kind of book which because of its style the British industrialist will call "academic" although in the sense of lacking practical application the adjective is quite unjustified.

The sequence of the text takes the reader through the fundamental notions of probability and of distributions in five fairly short chapters. Three chapters deal very thoroughly with the control chart for both measurement and counting, its modifications and the consequences of its use. The next three chapters deal with the problem of estimating the quality of a lot from a sample. Again measurement and counting number of defects are dealt with in parallel. The notion of confidence limits and the technique of sequential testing are introduced here. The last of these three chapters consists entirely of a discussion of the practical problem, in four different forms, of deciding whether "this" is different from "that". The remaining six chapters give the techniques for isolating and recognizing "the factors of heterogeneity". The analysis of variance technique is treated very thoroughly but only two and a half pages are devoted to experiment design. The analysis of covariance and related techniques for dealing with several simultaneously varying properties are introduced by a chapter on multivariate distributions. Fifty pages of tables and charts, all referred to in the text, round off this encyclopedia.

With such a wealth of material it may seem carping to ask for a little more on experiment design but having gone so far into the subject as to suggest techniques for isolating sources of variability the reader is ready to appreciate the need for design. The ample references do mitigate the omission and it may be that this subject is one of the few left for the second volume.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

There is a well-selected short list of books and a longer list of articles from French journals.

It occurs to the reviewer that teachers of the subject, and not necessarily only those dealing with industrial applications may find some inspiration in the concise, simple and direct explanations given of such concepts as confidence limits and tests of hypotheses. The typographical errors, of which a list is provided on a loose sheet, are none of them serious since they would mostly be evident from the context. To pick out two unusual features the reviewer noted (i) the "critical point" (reversal of trend) method of judging whether successive pieces from a process are statistically independent and (ii) the use of an upper *and* a lower limit for the F test even in the anlysis of variance.

E. D. VAN REST.

9.—*Tables of Normal Probability Functions.* National Bureau of Standards; Applied Mathematics Series, 23. Washington, 1953. ix + 344 pp. 10″. $2.75.

Probability Tables for the Analysis of Extreme-Value Data. National Bureau of Standards; Applied Mathematics Series, 22. Washington, 1953. iii + 32 pp. 10″. $0.25.

No tables have been more frequently published for use in statistics (or in the older theory of errors) than those of the ordinate and the integral of the normal probability function. For a long time the most extensive tables were those of Sheppard, published in *Biometrika* in 1903 and reproduced in *Tables for Statisticians and Biometricians.* The tables under review were first issued in 1942, and were prepared by the New York Mathematical Tables Project. They provide tables as detailed as anyone is ever likely to want. The main table is Table 1, covering 337 pages. The variable x is the standardized deviation from the mean of the normal distribution. At exceedingly fine intervals of x we are given, to fifteen decimal places, values of the ordinate at x and the area between $-x$ and $+x$. Between 0 and 1 the interval is 0·0001; from then on to 7·800 it is 0·001. By this time the ordinate has fallen to 25×10^{-15}, while the area has become $1 - 6 \times 10^{-15}$, so that the restriction to a fixed number of decimal places has meant that few *significant figures* are available at this end of the range. The final page winds things up by providing two short critical tables; the first gives ranges of x for which the ordinates are 24×10^{-15}, 23×10^{-15}, and so on, to the point where it is less than half a unit in the 15th decimal place; the other provides similar ranges of x for areas differing from unity by 6×10^{-15}, 5×10^{-15}, and so on, to the point where the area becomes unity to 15 decimal places.

To cope with the loss of significant figures alluded to in the preceding paragraph. Table II provides the ordinate and the area outside $\pm x$ to 7 significant figures for x ranging from 6 to 10 at intervals of 0·01. The power of 10 by which the tabulated values are to be multiplied is also given. It is a tribute to the care taken in the computation that no errors have been reported since 1942, although some argument misprints were corrected in the second edition, published in 1948. An adequate introduction is provided by Arnold N. Lowan. The tables are very clearly printed, but it is a slight disadvantage that they are in new style type, inevitable since they were reproduced from ordinary typescript.

The second publication under review from the same source is very different, both in size and utility. It owes its appearance largely to E. J. Gumbel, who contributes 15 pages of introduction, and who has given a great deal of attention, in his researches, to the sampling distributions associated with the extreme members of a sample of data, and with the range. He has also in the past shown the usefulness of studies of this sort, for example to meteorological data and to the forecasting of floods.

The distribution of the largest (or smallest) member of a sample of size n is considered in the special, but important, case of a parent population of exponential type, where the variate is unlimited in the direction of the largest (or smallest) member. This type covers normal and Type III distributions as well as the simple exponential. It is shown that for such types the (asymptotic) cumulative probability of the largest value of x is given by $\Phi_y = \exp(-e^{-y})$, a function which is given in Table 1 to seven decimal places for values of y ranging from $-3·0$ to 17·0. The interval varies, but is uniformly 0·05 from $-2·40$ to 0·00 and 0·1 from 0·0 to 4·0. The derivative of Φ_y, i.e., the ordinate of the frequency curve, is tabulated in the adjoining columns, and in both cases modified second differences, which are adequate for interpolation by the Everett formula, are provided. Table 2 is one of the inverse function. The value of y is given, to five decimal places, for Φ_y ranging from zero to unity. The interval is 0·0001 as far as 0·005, then 0·001 up to 0·988, 0·0001 to 0·9994 and 0·00001 to the end. Second differences are provided (modified beyond 0·997) and are adequate except for the last half-dozen entries. Table 3 gives the ordinate, to five decimal places, for $\Phi_y = 0·0000$ (0·0001) 0·010 (0·001) 0·999. Table 4 is a short one giving the probability points y_m for the mth extremes. This covers twelve values of Φ_m between 0·005 and 0·995 and a range of $m = 1$ (1) 15 (5) 50.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Finally there are two tables (Tables 5 and 6) relating to a different problem, that of the distribution of the range, i.e., the difference between the extreme sample measures, again for population distributions of the exponential type. The introduction explains what is meant by the "reduced" range R, while Table 5 gives the cumulative probability function $\Psi(R)$ and its derivative (the ordinate of the distribution) for R ranging from 1·00 (0·05) 11·00 (0·5) 20·0, to seven decimal places, with second differences (modified after $R = 11$). Table 6 is a half-page inverse table giving R at tabulated intervals of Ψ, to four decimal places (three at the extremes). The tables are clear, but presentation might have been improved in sundry ways, of which the chief would be to use old style type and less lining in. The introduction calls attention to the usefulness, in the problems dealt with here, of a specially devised form of probability paper, and contains a worked-out example dealing with flood flow.

J. WISHART.

10.—*Cambridge Elementary Statistical Tables.* By D. V. Lindley and J. C. P. Miller. Cambridge University Press, 1953. 35 pp. 11″. 5*s*.

A recent demand by the University of Cambridge for a set of statistical tables for use in examinations, in particular for the Natural Sciences Tripos examinations in Mathematics, prompted the University Press to have such tables prepared. The necessary statistical tables were few in number because of the restricted syllabus, but did not exist in suitable form. Ordinary mathematical tables were available, but it was further considered that the two lots could be combined with advantage in one small volume. This has now been prepared for general publication, and should command a wide sale, particularly as the price has been kept very low. The authors are D. V. Lindley, Lecturer in Mathematics at the University Statistical Laboratory, and J. C. P. Miller, Assistant Director of Research at the University Mathematical Laboratory, and well known as an expert on table construction.

The authors have broken with tradition by providing no introduction, being content with a single-page preface. This means that for illustrations of the use of the tables one has to have recourse to text-books, but this is no particular disadvantage since the tables are all well-known. Each has a small amount of accompanying matter in the body of the table itself. This sets out first the nature of the mathematical function which is tabulated, then states in words the statistical problem or test which involves this function, and lastly, where needed, hints on the appropriate method of interpolation, or on obtaining values beyond those tabulated, are provided. Table 1 gives the area under the normal curve from minus infinity to a standardized deviation x from the mean, where $x = 0{\cdot}00(0{\cdot}01)\ 3{\cdot}0(0{\cdot}1)\ 4{\cdot}0$, to four and five decimal places, with a useful critical table for the upper end of the range. There is also a table of the ordinate, to four decimal places, for $x = 0{\cdot}0(0{\cdot}1)4{\cdot}0$. Table 2 is the inverse table, giving percentage points of the normal distribution. A similar table for the t-distribution, with seven percentage points, and with values of ν (the number of degrees of freedom) going from 1 to 120 and infinity at varying intervals, forms Table 3. Table 4 is one of the inverse hyperbolic tangent, used to transform the correlation coefficient r into the approximately normally distributed variable z. Table 5 provides ten percentage points of the χ^2-distribution, for $\nu = 1(1)30(10)100$. A very brief Table 6 gives factors for converting range to standard deviation for samples of size 2 to 13. The most extensive statistical table is Table 7, which furnishes four percentage points of the F-distribution, for the usual range of the degrees of freedom ν_1 and ν_2.

A two-page Table 8 is an extract from a more extensive series of random sampling numbers. This brings us to the non-statistical part of the volume, and the largest table of all. Twenty pages are devoted to Table 9. First we have n^2 and $\sqrt{n}$, and the reciprocals of n and $\sqrt{n}$, for $n = 1(1)100$, to 4 and 5 decimals where not exact; then the inverse sine of $\sqrt{x}$ and the inverse hyperbolic sine of $\sqrt{x}$, $\sqrt{(10x)}$ and $\sqrt{(100x)}$, for $x = 0{\cdot}00(0{\cdot}01)1{\cdot}00$, to 3 decimals. Next, we have the main body of the table, giving x^2, $\sqrt{x}$, $\sqrt{(10x)}$, the reciprocals of x, $\sqrt{x}$ and $\sqrt{(10x)}$, and $\log x$ (i.e., to base 10), to varied numbers of decimal places from 3 to 5 where not exact, for $x = 1{\cdot}00(0{\cdot}01)10{\cdot}00$. Lastly, t is given, to 4 and 3 decimals, for $\log t = 0{\cdot}000(\cdot001)1{\cdot}000$. Table 10 gives the logarithms of factorials, to 4 decimals, for the numbers 0(1)300, and there is a final page of proportional parts.

The large page is needed in order to set out the tables clearly in suitably-sized blocks, and the whole is a beautiful example of modern mathematical table printing, an art in which the Cambridge University Press excel. This volume of Tables should become the indispensable companion to the ordinary working statistician who is satisfied with the accuracy provided, and a necessary part of the equipment of every statistical laboratory and practical classroom. It does not do away with the need for more extensive books of tables dealing with the more specialized functions, but such will be for occasional use and will be kept on the shelf; the volume under review is unlikely ever to leave the working table.

J. WISHART.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

11.—*The Economic Impact on Under-developed Societies.* By S. H. Frankel. Oxford: Blackwell, 1953. vii + 179 pp. $8\frac{3}{4}''$. 15*s*.

Professor Frankel has the advantage of combining two qualifications—an extremely concrete knowledge of economic problems in South Africa, and a capacity for philosophical reflection appropriate to a professor at Oxford. In South Africa, where he served for many years as a professor and consultant to the Minister of Finance, he not only studied and wrote on many aspects of South African life, but collected material for his great book, *Capital Investment in Africa.* In the days when national income compilation was still a field for amateurs, he provided for South Africa what was then one of the world's best series (subsequently taken over, with little change, by the official Statistics Department).

So far as the philosophical element in the book is concerned, the present reviewer cannot ever be more than an amateur critic. But it seems to consist of reasonable and plausible reflections. This is even true where the author resuscitates a controversy with the reviewer (at the International Statistical Conference of 1947), about the possibility of valid comparisons of real income per head between two different countries.

A book of reprints from previous publications only calls for a review in so far as it enables the author to reveal a general line of thought which is not apparent from the separate publications. The most valuable aspect of the author's train of thought comes out in his essay, "Whither South Africa?". He shows a really profound understanding of the history and economic structure of his native country. But the last essay in the book, "Some reflections on civilization in Africa", which the reader hopes will lead the train of thought to its climax, is padded with terrible quotations from Dickens, and fails—as others, too, have failed—to solve the basic problems of the conflict of races and civilizations.

An essay on the groundnut scheme gives the unhappy officials and politicians concerned a few more kicks after they are down, but is on the whole fair comment. It conveys the implication that, if the scheme had been allowed to develop very gradually instead of in a great hurry it might have worked; and does not discuss the more fundamental issue, whether really large-scale organization will not *always* prove unworkable in agricultural production.

Professor Frankel gleefully joins in the brisk fight which has developed round the United Nations "Measures for the Economic Development of Under-Developed Countries," to which he is wholeheartedly hostile. The authors of this well-known report must have expected it to arouse plenty of controversy. But if we look at the personalities of the three English-speaking members of the Committee—Professor Lewis of Manchester, Professor Gadgil of Poona and the cautious and scholarly figure of Professor Schultz of Chicago—we cannot dismiss the entire proposals as chimerical, as many critics have done.

We recognize Professor Frankel as an extremely accomplished statistician who has done a great deal to add to our knowledge of South African and other African economies. But this is hardly a book for the statistician, even a statistician as diverse and shallow in his interests as the present reviewer. It is however a book that could well be used in the training of administrators in Africa and other colonial territories, who are already well versed in their statistical or other technical knowledge, and require to broaden their minds before plunging into their actual duties. It will tell them a great deal that they do not know, and dispel some of the false notions which may be acquired in purely abstract study.

The reader may have gathered by now that Professor Frankel is advocating an essentially conservative point of view, not in the sense of supporting the Conservative Party which may, indeed, often be found moving rapidly in the opposite direction, but in the more fundamental sense of being sceptical about the ability of human reason to solve these problems and the desirability of leaving them, on some occasions at any rate, quietly to solve themselves.

But on one occasion, it is to be hoped inadvertently, he undoubtedly takes the wrong side. He quotes with approval from the works of Professor von Mises. There is not, Professor von Mises tells us categorically, and cannot ever be, any application whatsoever of quantitative methods in economics. Every economic problem must be solved by purely deductive reasoning which will lead, we know in advance, to Professor von Mises's own extreme brand of *laissez-faire*, and any statistician trying to work on economic problems is, by implication, an ignorant and dangerous meddler.

It is seriously to be hoped that Professor Frankel will recant this alliance. It is not to be taken lightly. The American mind has a tendency to unbalance and to the taking up of extreme positions. This is not an attempt to worsen international relations—the Englishman's tendency to be lethargic and complacent may in the long run do still more harm—but the American mind being as susceptible as it is, may well be tempted to take up Professor von Mises's jargon and to question his conclusions.

COLIN CLARK.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

12.—*Productivity and Economic Progress.* By Frederick C. Mills. National Bureau of Economic Research. Occasional Paper 38. New York, 1952. ii + 36 pp. 9″ $75.

This short pamphlet gives the results of a highly original quantitative investigation. Professor Mills examines two questions: First, what proportion of the substantial increase in the real national product of the United States over the last half century was contributed by labour input increment and by productivtiy increment respectively; second, how far has the increased product, considering the pattern of its uses, promoted economic progress.

In order to estimate such progress Professor Mills estimates first the requirements for the maintenance both of consumption standards and of capital stock. He assumes that the consumption level attained in a given decade (as measured by average *per capita* expenditures, in constant dollars, on consumption goods and services) establishes a criterion of consumption needs which carries over into the following decade. For capital stock, maintenance needs are equated to " capital consumption " during a stated period. He measures the changes over five consecutive decades and finds that over the five decades the margin above maintenance on both accounts averaged 25 per cent. of the gross product. For the five decades as a whole approximately 51 per cent. of this margin was used to raise consumption levels and 23 per cent. was used to create net additions to capital stock (the two items, which according to the author, taken together measure progress); the remaining 26 per cent. was used for defence. He also establishes that approximately two-fifths of the increment to the gross national product was due to increased labour input and three-fifths to increased productivity. Thus the sum of productivity increments equals 76 per cent. of the sum of the resources used for " progress " over the half century. " There can be no doubt, from the relative magnitudes involved, that the productivity factor . . . has played a major part in the advances in consumption levels and the expansion of capital plant that constitute economic progress".

It is obvious even from this short summary that the inquiry raises formidable problems of concepts and measurement which are not dealt with in this pamphlet, but which will be treated it appears, in a forthcoming monograph. There are three short methodological notes appended which indicate Professor Mill's awareness of the unprecise instruments which he had to use in his estimates, but they also indicate his conviction that the magnitudes of the movements measured are in most cases far greater than the magnitudes of the errors of measurement. One hopes that the fuller treatment envisaged will attempt, among other things, to split the effect of the productivity increase into two components: the one associated with shifts of labour, the other with productivity advances in the narrower sense. It would also be desirable to have more detailed treatment of the subject discussed in note 3 of the pamphlet. Here a procedure is described by which an increment in output is separated into three components: the one associated with an increase in labour input, another associated with a productivity gain, the third associated with the interaction between these two factors. This last, it appears, arises merely out of the fact that when both productivity and labour force are on the increase the latter operates at the new level of productivity. Lastly there is a small point of terminology which the reviewer at least found confusing. " Effort input " is used as the original definition and as an alternative term to the concepts of " labour input " or " work input ", although in fact, the author makes it abundantly clear that he means by all three terms merely the men at work or the manhours and that the " effectiveness of the effort " is measured through the productivity factor. L. ROSTAS.

13.—*World Population and Production.* By W. S. Woytinsky and E. S. Woytinsky. New York: Twentieth Century Fund, 1953. 1268 pp. $12.

The younger statisticians who have to deal with economic and social matters take it for granted that, on any question, they will now be able to find an abundance of reasonably accurate material. They may be unaware of the comparative recency of this satisfactory state of affairs, and of the labours of the statistical pioneers of an earlier period. They should not treat this issue with indifference; if only in order that they may understand and pardon some of the extraordinary errors into which the world has fallen, through lack of adequate statistical knowledge.

The now distant decade of the 1920's was not a very fruitful period statistically, in any country. When we look back over it, we are bound to give special credit to *Die Welt in Zahlen*, through which the world came to know Dr. Woytinsky, then a young Russian-born statistician of great originality and diligence. It required both courage and hard work to prepare this world summary of what were then deplorably inadequate and fragmentary statistics.

During the last few years, assisted by Mme. Woytinsky, and financed by the Rockefeller Foundation and the Twentieth Century Fund, he has returned to the task on a scale commensurate with present-day opportunities and needs. This massive volume still only represents half the task; a companion volume on " *World Trade and Organization* " is due shortly.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Even a well-endowed library thinks carefully before asking its bookseller to spend $12 for it, and it is the reviewer's duty to describe as precisely as he can what the purchaser can expect for his money. The best way to describe it, in a single sentence, is as a cross between a reference book and an encyclopedia. The user who categorically requires a reference book and nothing but a reference book will buy United Nations Statistical Year Book and Demographic Year Book, and renew them year by year if he can afford to—they are magnificent productions, but they are not cheap.

The larger and more interesting parts of all the tables in these Year Books are, however, to be found in Dr. Woytinsky's book (or to be expected in its companion volume). Likewise, many of the most interesting and important tables of *Statistical Abstract of the United States*—tables giving American information in more detail than can be obtained from world reference books, and classified by states and regions—are to be found here. Let this not, however, convey the impression that the book was primarily designed for American readers. It would be fair to say that it was designed for a world audience with some special interest in the United States.

For purposes of all but the most detailed study therefore, this book can take the place of some important (and expensive) reference books. But it does a great deal more than that. In each section, the tables are skilfully and logically linked together by appropriate and well-written text. The statistician, administrator or business man, deeply versed in his own branch of knowledge, from time to time finds it necessary to inform himself outside his own particular field, and he will get a great deal more information, with less difficulty, from this book than he would from reference books alone.

But also, in its numerous brief and incisive accounts of important aspects of the world economy, this book shares some of the attributes of an encyclopaedia. There is a definition of a well-educated man, as one who is accustomed to browse in encyclopaedias, which has a considerable element of truth in it. The reader will receive not only economics and demography, but in addition an agreeable (and generally accurate) combination of history, sociology, geography, climatology, agricultural science, industrial chemistry, and many other things on which he needs to be informed. Some of the historical studies, and reproductions of important ancient documents, are very well done; there is a real gem in the section on mining, which reproduces some of the rare 16th century drawings from Agricola's *De Re Metallica*. (It is pleasant to think of a former President of the United States, who is by profession a mining engineer—Mr. Herbert Hoover—preparing a fresh translation of this treatise.)

On the whole the best of the book is in the last section which deals in turn with each of the principal manufacturing industries, and gives the reader some interesting and up-to-date ideas about their technique, resources, and development in different parts of the world. The sections dealing with agriculture, minerals, energy and fuel also appear to be accurate and reasonably comprehensive.

While the reader can expect from this book adequate reference tables and useful information, technical and economic, on a large number of subjects, he cannot, however, expect a really deep or critical account. Thus, in the agricultural chapters, Dr. Woytinsky gives his readers (widely varying) estimates of the total cultivable area of the world made by different authorities, but does not criticize or reconcile them. Many people believe that the world's demand for fuel and energy is inexorably increasing. Dr. Woytinsky publishes a table showing how comparatively slow has been, since 1929, the increase in this demand (expressed in coal equivalents). Here again he makes little comment, nor does he attempt to forecast future demands for fuel. The section on industry, otherwise so good, is marred by a grave overstatement of the productivity of Australian industry.

The demographic section gives a useful summary of a good deal of information, but its treatment is often weak, uncritical, and not up-to-date. No doubt the book has been several years in preparation; but even if the author is unfamiliar with the revolutionary new methods of measuring fecundity published by M. Bourgeois-Pichat in 1950, he should be aware that the demographic trend has sharply turned upwards not only in France, but also in the U.S.A., and indeed in nearly all Western countries except England and Sweden. He still conveys the entirely erroneous impression that the population of the Western world is in a state of "incipient decline". On the very interesting demographic problem of the ratio of male to female births he quotes Newsholme's studies up to 1918, but gives a very misleading impression by failing to keep them up-to-date. (More recent French studies have shown that the tendency of this ratio to rise in war-time, and in certain other periods, can probably be explained in terms of the increased proportion of first births.) On differential fertility according to occupation, education, etc., he quotes a good deal of old material, but has apparently missed the important recent work, both census and private, on this subject in Sweden, the United States and France.

COLIN CLARK.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

14.—*Typenlehre der Demographie.* By Wilhelm Winkler. Vienna: Rudolf M. Rohrer, 1952. 160 pp. $9\frac{1}{2}''$.

The decline in the importance of the net reproduction rate in demographic analysis in recent years has been brought about mainly by a series of practical investigations among population data. The dangers of oversimplification have been amply demonstrated. Much of the new development has not been fully systematized, and there is thus room for a fresh approach to population mathematics, not necessarily in association with the stable population of Lotka.

Although the typology adopted by the author follows along the lines of his pre-war work and is thus largely unrelated to the latest researches, in some respects his analysis accords well with the views of at least one school of thought to-day. He accords prime importance to the number of births rather than to any intrinsic fertility rate. This approach has the merit of avoiding many mathematical difficulties. The trend of the number of births is given a polynomial form instead of progressing geometrically as in the stable population. Again, by discussing the effects of mortality variations, even though his assumptions are arbitrary, the author faces up to problems that are all too often by-passed in theoretical studies.

In its original version the manuscript of this book contained plenty of numerical illustrations and practical examples. It is unfortunate that the high cost of printing has caused the deletion of most of this material, as it would have been interesting to have the author's comments on the relationships between the abstract assumptions underlying his typology and the actual variations in experience that have occurred in several countries. In all probability, however, close comparisons would not have been possible, for as a result of the simple and direct approach chosen the analysis often consists of statements of inequalities between one population type and another rather than quantitative evaluations.

P. R. Cox.

15.—*Income and Wealth, Series II.* Edited by Simon Kuznets. International Association for Research in Income and Wealth. Cambridge: Bowes and Bowes, 1952. 328 pp. $8\frac{1}{2}''$. 35*s.*

Income and Wealth, Series III. Edited by Milton Gilbert. International Association for Research in Income and Wealth. Cambridge: Bowes and Bowes, 1953. xiii + 261 pp. $8\frac{1}{2}''$. 35*s.*

These two volumes contain a selection from the papers presented at the biennial conference of the International Association for Research in Income and Wealth held in 1951. The subjects treated are the analysis of economic growth by the use of long-term trends in income and wealth, the problems of international comparability of national income statistics, and topics related to these.

Series II contains two papers dealing respectively with the income and the wealth of the United States. "Long-term changes in the national income of the United States since 1870", by Professor Simon Kuznets, discusses changes in national income and expenditure over three-quarters of a century. Gross national product is analysed by industry and by distributive share, and is related to changes in the population, the labour force, migration and capital formation. Aggregates are given by value and by volume, and there is a number of interesting excursions into such fields as prices and productivity, leisure and consumption habits. The author acknowledges the incompleteness of his paper and the inconclusiveness of some of his analyses, and there is little point in stressing these facts, but readers who are not well acquainted with American statistics may be rather surprised at the wealth of data at Professor Kuznets' disposal. Some of these data, of course, are very crude indeed but their use by the author with a commendable nicety of caution and skill leads to results which should be reasonably acceptable.

"The growth of reproducible wealth of the United States of America from 1805 to 1950" is the title of Dr. Raymond Goldsmith's contribution to Series II. In this paper the trend of economic growth is approached from the capital as opposed to the income concept. Capital is here defined as "durable reproducible tangible wealth, excluding military tangible assets, subsoil assets, and civilian semi-durable and perishable assets"—a definition which may be completely acceptable to the economist but must cause acute distress to the linguist. The results of the study are interesting and are relatively clear cut. In real terms capital appears to have increased at the average annual rate of 2 per cent. per head of the population throughout the period, the growth being remarkably steady except during the years 1930 to 1945. The movement of the various constituents of the total capital are estimated, and the problems of estimation themselves receive a good deal of attention. The statistical material available for the first half of the century is very slight, but progressively improves during the second half of the century.

Series III contains ten shorter papers. Two of them deal with the statistics of economic growth in Japan and France respectively. "Long-term changes in the national product of Japan since 1878", by Messrs. Shigeto Tsuru and Kazushi Ohkawa, covers a remarkable period in Japanese

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

history. In the relatively short span of 60 years (1880 to 1940) national income at constant prices is estimated to have increased tenfold and the *per capita* figure sixfold. The rate of growth between the two World Wars was maintained at a particularly high level. "The national income of France since 1780", by members of the Institut de Science Economique Appliquée, reveals an astonishing abundance of statistical material for the nineteenth century. Indeed, the chief problems of the authors are those of selection and of reconciling the rival estimates of national income. When the most satisfactory estimates are chosen and linked together, a picture emerges of the French national income growing steadily between 1780 and 1914 both in monetary and in real terms, and at a rate much faster than the increase in the population. Since 1914, wars, inflation and depression have interrupted the long-term trend.

There are many papers on the international comparability of national income and social accounts, some having particular reference to the problem of comparing industrialized with under-developed countries. A paper by Messrs. Richard Stone and Kurt Hansen discusses the work done on international comparability in the Organization for European Economic Co-operation. The financial contributions of countries towards the expenses of the international organizations they support are usually based on some calculation of relative ability to pay, ability being assessed wholly or partly on national accounting data. The paper deals with the very difficult problems that arise in evolving a suitable system of standardized accounts on which such assessments could be more justly made. In the following paper Dr. Tibor Barna deals with the difficulty of obtaining a common concept of national income in the face of radical institutional differences between countries and wide disparities in their degree of economic development.

Professor Herbert Frankel considers that the meaning and worth of income depend to some extent on the social objectives of the community in which it is received and spent. Comparison between communities is prevented by an insoluble weighting problem—in comparing the United States and China the choice is between assuming in both countries either the American "way of life" or the Chinese "way of life"; there is no intermediate basis which could be regarded as common ground. In general, the scales of values possessed by acquisitive societies and traditional societies respectively are so devoid of common elements that no meaningful relationships between their incomes and their wealth can be established. Dr. Frederic Benham's paper, which follows, is a commentary on the views of Professor Frankel. Dr. Benham agrees that "ways of life" may be incommensurably different, but, he points out, what the average family consumes in each country is an objective and measurable fact; while such measurable categories may not take account of the whole situation, they have their uses.

Dr. V. K. R. V. Rao examines the effects of omissions, such as the unpaid services of housewives, and the possibilities of duplication in national income estimates on the comparability between industrialized and under-developed countries, and concludes that the income of industrialized countries tends to be over-estimated. Dr. Daniel Creamer, investigating "The uses of national income estimates in under-developed areas" considers that mere aggregates are of little use unless supplemented by a substantial amount of accurate detail. Even then they cannot obviate the need for other types of economic analysis.

Two papers remain to be considered—the first in Series III and the last.

In "Statistical sources and methods in national accounts estimates and the problem of reliability" Mr. Milton Gilbert discusses a matter that has been receiving increasing attention in recent years—the problem of indicating the margin of error attaching to national income estimates. In his opinion, the solution lies in the publication of critical reviews of the basic data used, their sources, and the uses to which they have been put. Since there is no objective method of assigning numerical margins of error to each component, the argument seems to be that sufficient information on sources and methods should be provided to enable subjective judgments to be passed by any readers who (being competent to do so) care to pass them. Clearly, the most satisfactory way of attacking this problem is to do everything possible to minimize the errors and Mr. Gilbert concludes his paper with an account of some of the methods which have been used in the United States to improve the accuracy of national income estimates.

Many readers may find the final paper, the "Treatment of government economic activity in the national accounts", by Mr. Ingvar Ohlsson, of particular interest. Preceding papers have mentioned the difficulties caused in international comparisons of national income by institutional differences which make it difficult to fit government activity into the same framework as the other sectors of the economy. Mr. Ohlsson enlarges upon this theme and suggests various alternative treatments of the government sector. He further suggests that alternative systems of accounts for the economy as a whole should be constructed, each being appropriate for a certain range of purposes.

T. M. RIDLEY.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

16.—*The Sterling Area: an American Analysis.* Prepared under direction of John M. Cassels, Director, Research and Statistics Division. London: Economic Co-operation Administration and H.M.S.O., 1951. 672 pp. $10\frac{3}{4}''$. 21*s*.

This is a book for every student of international trade and of post-war economic development. It is a better guinea's worth of applied economic analysis than has been seen for many years. The book contains first a general description of the economic structure of the sterling area and of its trading relations with the rest of the world, especially with North America, together with an account of post-war trends and policies. There follows a fairly detailed account of the economic structure and of recent economic developments in the United Kingdom and each principal sterling area country. Finally a series of chapters deals with commodities, both primary products and manufactures, important in sterling area trade—which means practically all major commodities.

The book covers in detail the post-war period up to mid-1950, with pre-war statistics as a basis for comparison. It is built on a very elaborate statistical framework. While the bulk of the statistics are official the authors have not hesitated to use unofficial sources or to compute new estimates where required. The most important original work is in the field of trade statistics. Convenient summaries of pre-war and post-war trade statistics are provided for the United Kingdom and other sterling area countries, and for the United States and Canada, analysed by area and commodity groups. In addition a valuable series of calculations of volume changes is included. These show, for 1934–38 and for 1949–50, by commodity groups, at constant prices, United Kingdom and United States trade with the outer sterling area, and with Canada; United Kingdom–United States trade; and United Kingdom–European trade. Similar figures are given for the volume of trade of each major sterling area country with the United Kingdom and the United States. These calculations are based mainly on the United Kingdom, United States and Canadian trade statistics, which have been assimilated under a common commodity classification (100 headings) based on the American export classification; the work was done, no doubt, before it became possible to use for this purpose, as would have been preferable, the United Nations Standard International Trade Classification of commodities.

The estimates of changes in volume of trade between pairs or groups of countries are derived by using average unit values for total trade in each commodity (or, more often, for the United States, the B.L.S. wholesale price indices). The method of course assumes that there are no significant differences in the composition of trade, in each commodity group chosen, between total trade and trade with a limited group of countries. The calculations over so long a period showing such great changes in the pattern of trade cannot therefore be regarded as necessarily reliable in detail. But they can reasonably be treated as reliable indicators of broad trends in the volume of international trade, and it is doubtful whether further practicable refinements of method would be justified by the improvement in accuracy. The full description of statistical methods and data given in the book is evidence of painstaking analysis as well as of ingenuity in filling unavoidable gaps.

Readers should note, incidentally, that the *Statistical Abstract for the Commonwealth* now provides consolidated trade statistics for the Sterling Area which (together with the summaries of Sterling Area trade published periodically in the *Board of Trade Journal*) enable one to keep up to date (although not always in the same form) much of the analysis of trade statistics used in the book under review.

The tables for the United Kingdom provide a number of most valuable estimates derived from budgetary and national income statistics. They include useful summary analyses of public authority revenue and expenditure, and the estimates, published earlier by Findlay Weaver, of the effects of taxation, direct and indirect, on the incomes of various social groups. The authors have also attempted a detailed analysis of the change since pre-war in the United Kingdom's external capital position.

Outside the field of trade statistics, the data available for the outer sterling area are often too sparse for sophisticated treatment. An attempt is made to provide for several Commonwealth countries indices of real national income per head for pre-war and post-war years. Except for the United Kingdom (for which special staff estimates were made for each item of national expenditure) current price data are simply deflated by retail and wholesale prices (weighted 2: 1 respectively). It is not the fault of the authors that the results inspire little confidence. It is also doubtful whether the validity of the international comparisons of the distribution of the labour force between sectors (Chart 2) should not be highly qualified in view of the wide possible differences of definitions in census data.

Although necessarily written with caution, the chapter on the United Kingdom is fair and sympathetic; the authors take pains to put in proper perspective the delicate points in Anglo-American relations—the deliberate development of intra-Commonwealth trade, the question of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the sterling balances, the redistribution of incomes and development of the Welfare State. The section on the United Kingdom, in spite of a non-committal approach, gives the feeling of being written from the inside; the sections on the outer Sterling Area countries, although informative and interesting, are less clearly written from first-hand knowledge.

Not much is said of the politics and technique of co-ordination of economic policy within the Sterling Area, and of the forces which bind together a continent, a sub-continent, most of a third continent, and a great number of islands all over the globe into a unit which possesses no common executive apparatus, and which certainly cannot in any literal sense be described as an "area" at all.

The book is superbly produced—it was printed in Holland—and special credit should go to the designers and printers of the fine charts and maps (in up to seven colours). Nothing so splendid has been seen here for a long time. But although artistic virtuosity may be detected at points, the charts are not only pleasing to look at: they exhibit complicated relationships with ingenuity and economy. Many parts of the book could be used with advantage as models for statistical presentation.

C. T. SAUNDERS.

17.—*Standard of Living in India and Pakistan*, 1931–32 *to* 1940–41. By R. C. Desai. Bombay: Popular Book Depot, 1953. xvii + 286 pp. $9\frac{3}{4}''$. *Rs.* 20.

The title of Dr. Desai's study will attract the reader who is seeking some appraisement of how far the scale of consumption which, in the decade 1930–40, was thought to be necessary for a reasonable existence for the mass of the Indian population had been achieved: a better title, therefore, would perhaps be National Income approached from the aspect of Estimated Expenditure and Consumption. Dr. Desai has compiled in two-thirds of his book comprehensive estimates of production and consumer expenditure in India in 1931–32 to 1940–41. With this material as background he estimates total and *per capita* expenditure in goods and services. Single handed, though with help and guidance from some well-known economists, both British and Indian, Dr. Desai has summarized with skill the considerable volume of statistical material on quantitative purchases, prices and values built up during the British administration, by districts and provinces. As would be expected in such an undertaking he found gaps in the available data and has made a sincere effort to keep a running account of errors in the estimates made of national income in the 1930–40 decade. The arbitrary steps he has taken in estimating are carefully explained. For the last pre-war year, 1938–39, Dr. Desai has, for the main items of consumer expenditure, classified the reliability of the estimates in four categories—A, good; B, fair; C, rough and D conjectures. Of the total consumer expenditure for all items of 25,852 million rupees, 7,910 million rupees fall into category A. Total expenditure on food alone in 1938–39 is estimated at 60 per cent. of total consumer expenditure (i.e., twice as high proportionately as in the United States and the United Kingdom). In the ten years included in the Survey the population of India increased from 338 to 389 million and the *per capita* expenditure showed a slight but gradual fall, reflecting increased pressure of population on subsistence. The high proportion of expenditure on food suggests that the standard of comfort in India was for large areas of population not markedly above the level of keeping the stomach reasonably filled. Dr. Desai has produced a study which will be valuable as a reference for future statistical work on the national income of India and Pakistan.

The present study relates to India as a whole and fills a gap between the work done by Dr. Rao before 1931–32 and the consideration given since the war to national income estimates for India by the National Income Committee. On reading Dr. Desai's book one is prompted to ask him many questions and to induce him to make a wider entry into the conjectural field. He does not tell us, although the title of his work suggests he would do so, how far the standard of comfort in India for the greater part of the population has fallen short of a practicable and desirable minimum standard of eastern living. Dr. Desai has made a notable and serious contribution to the studies of the national income of India.

J. H. GORVIN.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

British Official Statistics

The interim index of retail prices published by the Ministry of Labour and National Service remained stationary at 140 (prices at June 17th, 1947 = 100) from August to December, 1953. During this period the index for food prices fell mainly owing to reductions in the prices of eggs, milk and some kinds of fruit and vegetables. These were offset by increases in the price of coal, gas and, in some areas, electricity and by small increases in some articles of clothing. Separate figures on the same basis for different groups of commodities are not available, but the following are the figures based on January 15th, 1952 = 100.

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Alcoholic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
Aug. 18th, 1953	111·7	108·8	95·4	105·8	95·2	100·0	109·0	101·4	100·3	105·9
Sept. 15th, „	111·0	108·9	95·6	106·5	95·6	100·1	109·1	101·4	100·3	105·7
Oct. 13th, „	110·6	109·5	96·2	106·5	95·7	100·1	109·2	101·4	100·3	105·7
Nov. 17th, „	110·9	109·6	96·2	109·6	95·8	100·0	109·3	101·4	100·3	106·0
Dec. 15th, „	109·6	109·8	96·3	110·5	95·9	100·0	109·5	101·4	100·3	105·6

The Ministry of Labour index of weekly wage rates, which was 136 (June 30th, 1947 = 100) in August rose to 137 in September to November and 138 in December. The principal industries in which rates of wages rose during the period included dock labour, railways, gas supply, most of the retail distributive trades, boot and shoe manufacture, laundries, and agriculture in Scotland.

The total working population and the numbers in civil employment in the five months ending November, 1953, were as follows:

(*Thousands*)

	Total Working Population			*Number in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
July, 1953	15,864	7,488	23,352	14,841	7,373	22,214
Aug., „	15,918	7,555	23,473	14,890	7,430	22,320
Sept., „	15,924	7,559	23,483	14,897	7,428	22,325
Oct., „	15,931	7,576	23,507	14,895	7,439	22,334
Nov., „	15,926	7,598	23,524	14,887	7,462	22,349

The number of persons on the unemployment registers of the Employment Exchanges fell by 1,500 in September and rose by nearly 30,000 up to December. The total of 321,793 at December 7th represented 1·5 per cent. of the estimated total of employees in Great Britain. The percentages in the separate Regions ranged from 0·6 in the North Midlands and 0·7 in the Midlands to 2·1 in the Northern Counties, 2·7 in Wales and 3·0 in Scotland. The following is a sex analysis of the figures:

Number of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
Aug. 10th, 1953	190,913	102,623	293,536
Sept. 14th, „	184,148	107,822	291,970
Oct. 12th, „	193,648	115,417	309,065
Nov. 16th, „	203,608	119,087	322,695
Dec. 7th, „	207,466	114,327	321,793

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Of the total of 321,793 at December 7th, 11,930 were temporarily stopped, 86,280 had been unemployed for not more than 2 weeks, 91,840 for 2 to 8 weeks and 131, 743 for over 8 weeks.

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed, were 845,900 in September, 926,800 in October, 930,100 in November and 870,900 in December. The numbers of employees absent owing to industrial injuries were 60,200, 62,100, 62,000 and 57,000.

The aggregate membership of trade unions in the United Kingdom, as shown in the *Ministry of Labour Gazette* for November, was 9,524,000 at the end of 1952. This was about 43,000 more than at the end of the previous year and $3\frac{1}{2}$ million more than in 1938. Of the total membership 67 per cent. were in 17 unions with a membership of 100,000 or more, and 12 per cent. were in 16 unions with a membership of 50,000 to 100,000. General labour organizations accounted for 2,138,090 members, 1,759,070 were in metal trade unions and 837,020 in coal mining unions.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CURRENT NOTES

Fellows will learn with interest of the formation at the end of 1953 of the Yugoslav Statistical Society and will wish it every success in its development. The Society is composed of about sixty of the most prominent Yugoslav statisticians. Its aims are the development and furtherance of statistical methods and their application in various fields, and the maintenance of scientific and professional relations with similar international and national organizations. The first President of the Society is Dr. D. Vogelnik and the Honorary Secretary Dr. M. Macura.

Starting in 1954 North Carolina State College, the University of Florida, Virginia Polytechnic Institute and the Southern Region Education Board will sponsor jointly co-operative Graduate Summer Sessions in Statistics.

The sessions are designed to carry out a recommendation of the Southern Regional Education Board's Commission on Statistics, on which the three institutions initiating the programme are represented. They will be of particular interest to (1) research and professional workers who want intensive instruction in basic statistical concepts and who wish to learn modern statistical methodology; (2) teachers of elementary statistical courses who want some formal training in modern statistics; (3) prospective candidates for graduate degrees in statistics; (4) graduate students in other fields who desire supporting work in statistics; and (5) professional statisticians who wish to keep informed of advanced specialized theory and methods.

Each session will last six weeks and the courses are arranged to enable persons to take consecutive work in successive summers. The summer work in statistics may be applied at any one of the co-operating institutions in partial fulfilment of the requirements for a Master's degree.

During the first session Professor M. G. Kendall of the University of London will give a course in Multi-variate Analysis, and Dr. Ralph Comstock of North Carolina State College one in Quantitative Genetics.

The Staff of the Virginia Polytechnic Institute's Department of Statistics will offer such courses as Probability and Inference, Analysis of Variance, Statistical Methods, Engineering Statistics, Education Statistics, Rank Order Statistics and the Theory of Sequential Methods.

Full information may be obtained from Dr. Boyd Harshbarger, Head of the Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Virginia.

Thomas Bayes.—The Rev. Thomas Bayes, F.R.S., author of the first attempt at a quantitative theory of inductive inference, is strangely neglected in standard works of biographical reference. The *Dictionary of National Biography* has an entry on his father, Joshua, and refers to his great-uncle, Samuel (incorrectly described as Joshua's father), but Thomas has no entry.

Enquiries by various Fellows of the Society, and by Mr. Fletcher, of the Department of Mathematics, Liverpool University, have brought to light some biographical details on Thomas Bayes. Following a suggestion of the President, it is hoped to publish in the Society's Journal a biographical notice of Bayes, and any reader who may have relevant information is asked to get in touch with Professor G. A. Barnard, Department of Mathematics, Imperial College, S.W.7.

Particular interest attaches to two questions: (*a*) Is it possible that Bayes was taught mathematics by de Moivre, who was giving private tuition in London when Bayes was of school age? and (*b*) what was the nature of the association between Bayes and the Rev. Richard Price, who published Bayes's posthumous paper?

The Fellows named below were included in the New Year's Honours List of 1954:

C.B.E.: Professor R. G. D. Allen, O.B.E.
O.B.E.: T. M. Ridley.

The recent election of Professor A. Bradford Hill to the Fellowship of the Royal Society has given much satisfaction to the Council and Fellows of our own Society. We offer Professor Bradford Hill sincere and cordial congratulations on this outstanding distinction.

Fellows will be glad to learn that Dr. H. O. Hartley, formerly of University College, London, and now with the Iowa State College, has been elected a Fellow of the American Statistical Association.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

OBITUARY

Dr. W. T. Russell

W. T. Russell was born in Killarney in 1888, the son of a schoolmaster. He was educated at Black Rock, Dublin, and settled in England before the first world war. In 1915, after a period of commercial employment, he joined the staff of the Medical Research Committee (later the Medical Research Council) and continued in medical statistical work for the Council until 1943. Up to 1927 he worked with Dr. John Brownlee (for much of the time at the National Institute for Medical Research) and thereafter, following Brownlee's death, with Professor Major Greenwood at the London School of Hygiene and Tropical Medicine. The work at the School brought him particular satisfaction, as it utilized his gifts for teaching and for research work to the full. In 1943 he accepted an invitation from Professor John Ryle to become statistician to the newly-formed Institute of Social Medicine in Oxford, and was working there up to his death in July, 1953. He was elected a Fellow of the Society in 1930.

Russell wrote many sound papers in the field of vital statistics, covering such subjects as the epidemiology of diphtheria in this country from 1901 to 1940 (a study for which he was awarded the D.Sc. of London University), the effects of fog and cold upon the mortality from respiratory disease, the geographical and secular pattern of tuberculosis, the sex-ratio at birth, and appendicitis. He was full of ideas for investigations and had a flair for discovering unusual sources of material. In his papers he always preferred a direct approach and a simple table to more refined statistical techniques, which he often felt to be an unnecessary sophistication. He was liberal with his advice and time to all who consulted him, giving encouragement and practical assistance freely, and however substantial his contribution to a joint investigation might be, he invariably wished to take the minimum of credit for himself.

It is not only for this scientific work but also for his personal qualities that Russell will long be remembered. His cheerfulness, his delight in a good story, his unaffected pleasure on meeting old friends, and his love of reminiscence endeared him to everyone. Even the most casual acquaintance was impressed by the warmth of his friendliness; those who knew him better found that it sprang from a deeply Christian life. He had a rare concern for the welfare of others. He would never proffer advice, but the many who approached him with personal problems found him both sympathetic and practical, with a wise understanding of people and of personal relationships. He was an altogether lovable man.

Ian Sutherland.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Annals of Eugenics—

September 1953—The use of χ^2 in testing effect of birth order: *M. Halperin.* The fitting of the positive binomial distribution when both parameters are estimated from the sample: *F. E. Binet.* The general purpose sib-pair linkage: *L. S. Penrose.*

Biometrika—

December 1953—The population frequencies of species and the estimation of population parameters: *I. J. Good.* Capture-recapture analysis: *J. M. Hammersley.* The use of chain-binomials with a variable chance of infection for the analysis of intra-household epidemics: *N. T. J. Bailey.* Spread of diseases in a rectangular plantation with vacancies: *G. H. Freeman.* Tests of significance for concurrent regression lines: *E. J. Williams.* Approximate confidence intervals. II. More than one unknown parameter: *M. S. Bartlett.* Non-normality and tests on variances: *G. E. P. Box.* Approximating to the distributions of measures of dispersion by a power of χ^2: *J. H. Caldwell.* The power function of some tests based on range: *H. A. David.* Some simple approximate tests for Poisson variates: *D. R. Cox.* Orthogonal polynomial fitting: *J. Wishart* and *T. Metakides.* Population differences between species growing according to simple birth and death processes: *J. H. Darwin.* Modifications to the variate-difference method: *M. H. Quenouille.* Moments of the rank correlation coefficient r in the general case: *R. M. Sundrum.* 99·9 and 0·1 per cent. points of the χ^2 distribution: *T. Lewis.* Tables of symmetric functions. Part IV: *F. N. David* and *M. G. Kendall.* Some procedures for comparing Poisson processes or populations: *A. Birnbaum.* Scale factors and degrees of freedom for small sample sizes for χ-approximation to the range: *G. W. Thomson.* The third moment of Gini's mean difference: *A. R. Kamat.* A method of systematic sampling based on order properties: *R. M. Sundrum.* A note on ordered least-squares estimation: *F. Downton.* A note on the evaluation of the multivariate normal integral: *F. N. David.* A graphical method for the analysis of statistical distributions into two normal components: *E. J. Preston.* A note on regions for tests of kurtosis: *G. E. P. Box.* The frequency justification of sequential tests—addendum: *G. A. Barnard.*

British Journal of Sociology—

September 1953—Productivity and the worker: *W. C. Balfour.*

British Journal of Statistical Psychology—

November 1953—The relation of the Terman-Merrill vocabulary test to mental age in a sample of English children: *M. I. Dunsdon* and *J. A. Fraser Roberts.* The submissiveness of nations: *L. F. Richardson.* The factor analysis of matrices of negative correlations: *P. Slater.*

Cambridge Philosophical Society, Proceedings—

October 1953—On counters with random dead time—I: *J. M. Hammersley.*

Economica—

November 1953—Long-run adjustments in the balance of trade: *A. C. Pigou.* Concentration in tropical trade: some aspects and implications of oligopoly: *P. T. Bauer.*

Incorporated Statistician—

October 1953—Road accidents: *G. Prys-Williams.* Correlation for the non-mathematician (part II): *J. Keen* and *A. N. James.* The statistical approach to weights and measures: *D. J. Desmond.* Retail audit research: *J. A. P. Treasure.* Some notes on occupations and socio-economic groups: *L. Parkinson.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Institute of Actuaries, Journal—

Vol. LXXIX, Part II, No. 352—The use of sampling in pension fund valuations: *F. Gordon Smith.* On the nature of the function expressive of the law of human mortality: *M. E. Ogborn.* Some probability results for mortality rates based on insurance data: *J. E. Walsh.*

Institute of Actuaries Students' Society, Journal—

Vol. XII, Part 2—France and Great Britain—a demographic comparison: *P. R. Cox.* The decline in spinsterhood (contd.): *W. S. Hocking.*

Manchester School of Economic and Social Studies—

September 1953—Allocation and programming in modern economics: *K. S. Lomax.* Wage rates and earnings in the cotton industry from 1946 to 1951: *G. Evans.* Employment for women in the development areas 1939–51: *J. H. Dunning.*

Oxford Economic Papers—

October 1953—How long does a Company live: *G. Lindgren.*

Oxford University Institute of Statistics, Bulletin—

September 1953—Earnings and living standards in Moscow. I. A comment: *G. H. Elvin.* Earnings and living standards in Moscow. II. A rejoinder: *T. Schulz* and *P. Wiles.* Average wages in U.S.S.R.: *P. Wiles.*

October–November 1953—National survey of personal incomes and savings: Part IV: Personal savings and consumption expenditure: *H. F. Lydall.* The instability of sterling commodity prices: *C. D. Harbury* and *E. Nevin.*

Population Studies—

November 1953—Résumé of the Indianapolis study of social and psychological factors affecting fertility: *C. V. Kiser* and *P. K. Whelpton.* Age at marriage and proportions marrying: *J. Hajnal.* The derivation of fertility and reproduction rates from restricted data on reproductive histories: *W. Brass.* Some estimates of the general age distribution, fertility and rate of natural increase of the African population of British East Africa: *C. J. Martin.*

Review of Economics and Statistics—

August 1953—The process of capital formation in inventories and the vertical propagation of business cycles: *R. P. Mack.* Endogenous and exogenous investment in macroeconomic models: *G. H. Fisher.*

Society of Actuaries, Transactions—

October 1953—The dip in mortality in the twenties of age: *W. G. Bowerman.* The mathematical risk of lump-sum death benefits in a trusteed pension plan: *H. L. Seal.*

June 1953—Three arms races and two disarmaments: *L. F. Richardson.* Discriminant functions for genetic differentiation and selection: *C. R. Rao.* Contribution to the calculus of the mathematical expectation: *I. Lah.* Large sample confidence intervals for density function values at percentage points: *J. E. Walsh.* On estimating the parameters of bivariate normal populations from doubly and singly linearly truncated samples: *D. Raj.* A rapid method of estimating basal area in timber survey—an application of integral geometry to areal sampling problems: *M. Masuyama.* Statistics: *R. A. Fisher.* The work of the United Nations sub-commission on statistical sampling: *F. Yates.*

UNITED STATES—

American Economic Review—

September 1953—The burden of Soviet taxation: *F. D. Holzman.* Cyclical turning points: Canada, 1927–1939: *E. Marcus.*

American Economic Review, Supplement—

September 1953—Graduate education in economics: *H. R. Bowen.* (Whole number.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

American Statistical Association, Journal—

September 1953—Measuring the accuracy and structure of businessmen's expectations: *R. Ferber*. Electronic computation in economic statistics: *J. A. C. Brown, H. S. Houthakker* and *S. J. Prais*. The elements of an industrial classifications policy: *W. R. Simmons*. Experimental designs and probability sampling in marketing research: *M. E. Brunk* and *W. T. Federer*. Improving national marriage and divorce statistics: *H. Carter*. Sampling the federal old-age and survivors insurance records: *B. J. Mandel*. Statistics in chemical experimentation: *C. Daniel*. Life testing: *B. Epstein* and *M. Sobel*. Methods of measuring useful life of equipment under operational conditions: *L. A. Goodman*. On some procedures for the rejection of suspected data: *E. P. King*. On the use of ranges, cross-ranges and extremes in comparing small samples: *H. Hyrenius*. The distribution of the product of ranges in samples from a rectangular population: *P. R. Rider*. Confidence and tolerance intervals for the normal distribution: *F. Proschan*. A statistically precise and relatively simple method of estimating the bio-assay with quantal response, based on the logistic function: *J. Berkson*. Critical values of the log-normal distribution: *J. Moshman*. The partition of error in randomized blocks: *O. Kempthorne* and *W. D. Barclay*.

American Statistician—

October 1953—Developments of statistical programs in mid-American universities and colleges: *P. O. Johnson*. Production of vital statistics as a combined federal-state operation: *O. K. Sagen*. Binary coding, horizontal card fields and the electronic statistical machine: *H. P. Hartkemeier*.

Annals of Mathematical Statistics—

September 1953—An essentially complete class of decision functions for certain standard sequential problems: *M. Sobel*. Stochastic processes occurring in the theory of queues and their analysis by the method of the imbedded Markov chain: *D. G. Kendall*. On the stochastic matrices associated with certain queuing processes: *F. G. Foster*. Bounds on a distribution function when its first n moments are given: *H. L. Royden*. On some theorems in combinatories relating to incomplete block designs: *K. N. Majumdar*. The Behrens-Fisher problem for regression coefficients: *D. A. S. Fraser*. Sequential decision problems for processes with continuous time parameter. Problems of estimation: *A. Dvoretzky, J. Kiefer* and *J. Wolfowitz*. Distribution of quadratic forms and ratios of quadratic forms: *J. Gurland*. Scaling and error analysis for matrix inversion by partitioning: *M. Lotkin* and *R. Remage*. On certain classes of statistical decision procedures: *H. S. Konijn*. A double sample test procedure: *D. B. Owen*. Some tests based on ordered observations from two exponential populations: *B. Epstein* and *Chia Kuei Tsao*. Power functions of the sign test and power efficiency for normal alternatives: *W. J. Dixon*. The admissibility of certain invariant statistical tests involving a translation parameter: *E. L. Lehmann* and *C. M. Stein*. A note on Dodge's continuous inspection plan: *G. J. Lieberman*. On the power of a one-sided test of fit for continuous probability functions: *Z. W. Birnbaum*.

Bell System Technical Journal—

September 1953—The correlograph—a machine for continuous display of short term correlation: *W. R. Bennett*. A statistical study of selective fading of super-high frequency radio signals: *R. L. Kaylor*.

Biometrics—

September 1953—On stochastic processes in biology: *A. T. Reid*. A method for comparing fly-repellant sprays: *M. J. R. Healy*. An example of the use of fractional replications: *O. Kempthorne* and *R. G. Tischer*. A statistical design for the efficient removal of trends occurring in a comparative experiment with an application in biological assay: *G. E. P. Box* and *W. A. Hay*. A dose-response equation for the invasion of micro-organisms: *S. Peto*. Analysis of egg shape of chickens: *F. T. Shultz*. A generalization of Neyman's contagious distributions: *G. Beall* and *R. R. Rescia*. Quality x quantity interaction: *A. A. Rayner*. Strawberry uniformity yield trials: *G. A. Baker* and *R. E. Baker*. Analysis of a triple rectangular lattice design: *V. N. Murty*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Econometrica—

July 1953—Comptabilité nationale et tableaux économiques: *R. Mercier.* Goodwin's non-linear theory of the business cycle: an electro-analog solution: *R. H. Strotz, J. C. McAnulty* and *J. B. Naines, Jr.* Balanced growth under constant returns to scale: *R. M. Solow* and *P. A. Samuelson.*

October 1953—Le comportement de l'homme rationnel devant le risque: critique des postulats et axiomes de l'école Americaine: *M. Allais.* A spatial equilibrium model of the livestock feed economy in the United States: *K. A. Fox.* On a pooling problem from the statistical decision viewpoint: *W. D. Fisher.* On the optimal character of the (*s*, *S*) policy in inventory theory: *A. Dvoretzky, J. Kiefer* and *J. Wolfowitz.* Nonnegative square matrices: *G. Debreu,* and *I. N. Herstein.* A theorem on the construction of voting paradoxes: *D. C. McGarvey.*

Estadística—

September 1953—Las estadísticas del turismo: problemas básicos y situación en los paises Americanos: *A. V. Bangha.* A national identity registration system to synthesize social statistics: *H. L. Dunn.* Métodos y problemas del Primer Censo de Comercio e Industrias de Costa Rica, 1950–1951: *W. J. Castro.* Special vegetable surveys in the New York City market area: *I. Holmes.* Los censos industriales en las naciones Americanas: *R. W. Bruton.*

INDIA—

Sankhya—

Industrial Quality Control—

September 1953—Some influence of paper machine design and operation on variability of paperboard: *C. A. Bicking* and *R. T. Trelfa.* A survey and evaluation of types of quality control education: . *A. Henry.* Quality control as a methods improvement function in automotive and aircraft parts manufacturing: *E. F. Gibian.* The use of statistics in food processing: *S. Harrison.* Estimating the standard deviation of a normal population: *E. P. King.* Quality control in receiving inspection: *E. F. Graumenz.* Some remarks concerning the lot plot plan: *C. C. Craig.* The use of average and range charts to control material consumption: *H. R. Bolton.*

Journal of Political Economy—

October 1953—The population upsurge and the American economy: *J. S. Davis.*

Mathematical Tables and Other Aids to Computation—

July 1953—Stability conditions in the numerical treatment of parabolic differential equations: *E. C. du Fort* and *S. P. Frankel.* On over and under relaxation in the theory of the cyclic single step iteration: *A. Ostrowski.* The accuracy of numerical solutions of ordinary differential equations: *T. E. Sterne.*

Milbank Memorial Fund Quarterly—

October 1953—Effect of frequency of family visiting upon the reporting of minor illnesses: *J. Downes* and *J. C. Mertz.* Progress in school of children in a sample of families in the Eastern Health District of Baltimore, Maryland: *M. Keller.* Social mobility and fertility within an elite group: *E. D. Baltzell.*

Operations Research Society of America, Journal—

November 1953—Sampling methods in railroad accounting: *W. R. van Voorhis.* Methods of reducing sample size in Monte Carlo computations: *H. Kahn* and *A. W. Marshall.* State probabilities in congestion problems characterized by constant holding times: . *L. Everett.* Combat problems, weapon systems, and the theory of allocation: *A. Karchere* and *F. P. Hoeber.*

Psychometrika—

September 1953—Application of a large sampling criterion to some sampling problems in factor analysis: *D. D. Rippe.* Approximate maximum test validity by a non-parametric

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

method: *H. Webster*. A note on the Neyman-Johnson technique: *R. P. Abelson*. The stability of the factorial pattern of aircrew classification tests in four analyses: *V. Zachert* and *G. Friedman*. Reliability formulas that do not assume experimental independence: *L. Guttman*. Note on Miller's "Finite Markov processes in psychology": *R. C. W. Kao*. A further note on "Finite Markov processes in psychology": *L. A. Goodman*. A proposed index of the conformity of one sociometric measurement to another: *L. Katz* and *J. H. Powell*. Differences in factor content of rights and wrongs scores: *B. Fruchter*.

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. VI, Parts 1/2—Die Änderung des Zahlenverhältnisses der aktiven und nichtaktiven Bevölkerung Österreichs durch den Geburten und Sterberückgang 1910 bis voraussichtlich 1969: *W. Winkler*. Indexzahlen-probleme: *W. Winkler*. Zur Theorie des Konjunkturtestes: *O. Anderson, jun.* Das Betriebsspektrum: *A. Adam*. Ein Beitrag zur Testung der Panmixie: *W. Ossadnik*.

BELGIUM—

Bulletin de l'Institut de Recherches Economiques et Sociales—

November 1953—L'Etude de la société urbaine. Synthèse de recherches: *D. Szabo*.

GERMANY—

Weltwirtschlaftliches Archiv—

Vol. 71, Part 1—Saving, investment and imperialism: a reconsideration of the theory of imperialism: *L. J. Zimmerman*. Wachstum und Entwicklungsaussichten der amerikanischen Wirtschaft: *W. G. Hoffman*. British monetary policy, 1945–1952: *J. Lanner*.

ITALY—

Giornale degli Economisti—

August 1953—Sugli indici di riproduzione: *M. D. Vergottini*.

Statistica—

July-September 1953—Osservazioni sulla ricerca dell'associazione di caratteri istologici: *G. Barbensi*. Distribuzione dei redditi e composizione familiare: *A. Bellettini*. La eliminazione degli iscritti agli uffici di collocamento: *R. Lenzi*. I criteri di R. A. Fisher per la scelta di una buona stima ed il metodo della massima verosimiglianza: *L. Vajani*.

JAPAN—

Institute of Statistical Mathematics, Annals—

Vol. V, No. 1—A metrization of class-convergences of distributions: *K. Takano*. Estimation by the minimum distance method: *J. Wolfowitz*. On the chi-square test for weighted samples: *H. Aoyama*. A quantification of social status: *S. Nisihira*. On the many-dimensional distribution functions: *K. Takano*.

SWEDEN—

Skandinavisk Aktuarietidskrift—

Part 1–2, 1953—Research in collective risk theory. The case of equal risk sums: *G. Arfwedson*. The distribution of the partial correlation coefficient in samples from multivariate universes in a special case of non-normally distributed random variables: *C-E. Quensel*. On Neyman's smooth test of goodness of fit and its power with respect to a particular system of alternatives: *D. E. Barton*. Similarity, unbiasedness, minimaxibility, and admissibility of statistical test procedures: *E. Sverdrup*. Markoff chains as an aid in the study of Markoff processes: *A. Jensen*. The multi-variate sampling problem: *T. Balenius*.

Skandinavisk Aktuarietidskrift, Supplement—

Part 1–2 1953—The distribution of t- and F-statistics and of correlation and regression coefficients in stratified samples from normal populations with different means: *M. Weibull*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part IV, 1953, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Board of Trade.* Census of distribution and other services 1950. Vol. I. Retail and service trades, area tables. London, H.M.S.O., 1953. vi, 158p. 11¾″. 7*s.* 6*d.*

General Register Office. The Registrar General's decennial supplement England & Wales 1931. Part IIB. Occupational fertility 1931 & 1939. London, H.M.S.O., 1953. vi, 99p. 12″. 13*s.* 6*d.*

Registry of Friendly Societies. Report of the Chief Registrar of Friendly Societies, for the year 1952. Part 3. Industrial and provident societies. London, H.M.S.O., 1953. ii, 44p. 11¾″. 4*s.* 6*d.*

Scotland. General Registry Office. Census 1951: report on the fifteenth census of Scotland ... Vol. I.—Part 2. City of Glasgow. Edinburgh, H.M.S.O., 1952. 57p. 13″. 10*s.* Part 7. County of Argyll. 44p. 11*s.* Part 8. County of Ayr. 58p. 15*s.* Part 9. County of Banff. 39p. 10*s.* Edinburgh, H.M.S.O., 1953. 13″.

Scottish Health Services Council. The ageing population: report by the Standing Medical Advisory Committee. Edinburgh, H.M.S.O., 1953. 13p. 9½″. 6*d.*

Australia. *Commonwealth Bureau of Census and Statistics.* Census of the Commonwealth of Australia. 30th June, 1947. Statistician's report. Canberra, [1952]. xiv, 386p. 13″. 5*s.*

Census of the Commonwealth of Australia 30th June, 1947. Vol. II. Comprising parts XVII to XIX of the detailed tables ... Canberra, [1952]. v, 929–1601p. 12¾″. Part XXIII.—Analysis of dwellings in local government areas: South Australia. p. 1803–1849. Part XXIV.—Analysis of dwellings ... Western Australia. p. 1853–1899. Part XXV.—Analysis of dwellings ... Tasmania. p. 1903–1924. Part XXVI.—Analysis of dwellings: Australian Capital Territory, Northern Territory, Papua-New Guinea, Norfolk Island, Nauru. p. 1927–1944. Canberra, 1953. 13″. 2*s.* 6*d.* each part.

Belgium. *Institut National de Statistique.* Recensement général de la population, de l'industrie et du commerce au 31 décembre 1947. Tome VIII. Répartition de la population d'après l'activité et la profession. 359p. Tome IX, Tome IX bis. Recensement du commerce. 2 vols. Tome X. Recensement de l'industrie. 408p. Bruxelles, 1953. 11½″. Tome XI, Tome XI bis. Salaires dans l'industrie. Bruxelles, 1952. 2 vols. 11½″.

Brasil. *Instituto Brasileiro de Geografia e Estatistica.* Recenseamento geral do Brasil (1 de Setembro de 1940). Serie regional. Parte I–V, VII–VIII. Rio de Janeiro, 1952. 7 vols. 10¾″.

Serviço Nacional de Recenseamento. VI recenseamento geral do Brasil. Censo demográfico (1 de Julho de 1950). Estado de Minas Gerais: seleção dos principais dados. viii, 88p. Estado do Paraná ... viii, 36p. Estado de Santa Catarina ... vii, 34p. Estado de São Paulo ... viii, 76p. Rio de Janeiro, 1953. 10¾″.

Burma. *Ministry of National Planning.* The national income of Burma [1938–39 and 1946–47]. [Rangoon], 1951. iii, 44p. 9¾″.

Eire. *Central Statistics Office.* Census of population of Ireland 1946. Vol. III part I. Religions. Part II. Birthplaces. Dublin, The Stationery Office, 1952. ix, 131p. 9¾″. 4*s.* 6*d.*

France. *Institut National de la Statistique et des Études Économiques.* Résultats statistiques du recensement général de la population effectué le 10 mars 1946. Résultats par départements: population légale, état civil et activité professionnelle de la population présente, familles, immeubles, menages et logements. Tome I–VI. Paris, Presses Universitaires de France, 1951. 6 vols. 10½″.

Germany. *Statistisches Bundesamt.* Die Bevölkerung der Bundesrepublik Deutschland nach der Zahlung vom 13.9.1950. Heft 5. Die verheirateten Frauen nach Eheschliessungsjahren, Geburtsjahren und Kinderzahl. 16p. (Statistik der Bundesrepublik Deutschland, 35.) Die berufliche und soziale Gliederung der Bevölkerung der Bundesrepublik Deutschland nach der Zahlung vom 13.9.1950. Teil II Heft 4. Die Erwerbspersonen und die Ehefrauen ohne Hauptberuf nach ihrer Sicherung bei Krankheit und nach der voraussichtlichen Altersversorgung. 21p. (S.B.D. 37.) Stuttgart-Köln, W. Kohlhammer, 1953. 11¾″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Handbuch der internationalen statistischen Klassifizierung der Krankheiten Gesundheitsschädigungen und Todesursachen. 6. Uberarbeitung des internationalen Verzeichnisses der Krankheiten und Todesursachen; angenommen 1948 von der Weltgesundheitsorganisation in Genf. Deutsche ausg. Band 3. Ausführliche deutsche Systematik: systematik und alphabetisches Verzeichnis der Art der Schadigung. [Stuttgart-Köln, W. Kohlhammer], 1953. xii, 188p. 9½″.

India. *National Physical Laboratory.* Indian National Scientific Documentation Centre: report 1952–53. Delhi, [1953]. ii, 12p. 8½″.

International Labour Office. Textile wages: an international study. Geneva, 1952. v, 126p. 9½″. 4*s.* 6*d.* (Stud. and Rep., New Ser., 31.)

Mexico. *Direccion General de Estadistica.* Septimo censo general de poblacion, 6 de junio de 1950. Mexico, D.F., 1952–1953. 32 vols. 10½″.

Netherlands. *Centraal Planbureau.* Economische invloeden van een vermeerdering der militaire uitgaven in een volkshuishouding als die van Nederland; door J. Lips. *Economie* (1953), **Juni,** 1–19. 9¼″. (Repr. Ser., 24.)

On the time shape of economic microvariables and the Munich business test; [by] H. Theil. *Rev. Inst. Int. Statist.* (1952), **20**, 16p. 9¾ . (Repr. Ser., 25.)

New Zealand. *Census and Statistics Department.* Official estimates of national income and sector accounts 1938– 39 –1952–53. Wellington, 1953. 60p. 11″.

Population census 1951: New Zealand life tables 1950–1952. Expectations of life: chances of living and dying at each age, non-Maori lives. Wellington, 1953. 17p. 11″.

North Borneo. A report on the census of population held on 4th June, 1951; by L. W. Jones ... Jesselton, North Borneo, and London, Crown Agents for the Colonies, 1953. v, 237 p. $12.

Norway. *Statistisk Sentralbyrå.* Forbruksundersøkelse 1952, etter Intervjumetoden. Oslo, 1953. 31p. 9½″. (Norg. Off. Statist. XI.131.)

Ontario. *Department of Agriculture.* Agricultural statistics for Ontario ... 1952. Toronto, [1953]. 101p. 9¾″.

Puerto Rico. *Census Office.* Census of Puerto Rico: 1935. Agriculture: farms and farm property, crops and livestock ... 1937. Population: bulletin no. 1. Number and distribution of inhabitants ... 1936. Population: bulletin no. 2. Characteristics of the population including occupations ... 1937. Washington, Supt. of Documents, 1936–1937. 3 parts in 1 vol. 11″.

Sweden. *Statistiska Centralbyrån.* Folkpensioneringen jämte sjukkasseväsendet M. M. åren 1939–1950. Stockholm, 1953. 71p. 9½″. (Sverig. Off. Statist.)

Folkräkningen den 31 December 1950. II. Uralsundersökningar statistiken över ålder, kön, civilstand yrke och familjer. Stockholm, 1953. 86p. 9½″. (Sverig. Off. Statist.)

United Nations. *Department of Social Affairs. Population Division.* Training in techniques of demographic analysis. New York, 1953. iv, 17p. 10¾″. 1*s.* 9*d.* (Population Studies, 18.)

United States of America. *Bureau of the Census.* The population of Czechoslovakia; by Waller Wynne, Jr. . . . Washington, Supt. of Documents, 1953. vi, 72p. 10¼″. 40*c.* (Int. Popul. Statist. Rep., Ser. P-90, no. 3.)

United States census of business 1948. Vol. I, II, IV, VI. Washington, Supt. of Documents, 1952. 4 vols. 11½″.

Office of Business Economics. Statistical supplement to the Survey of Current Business. 1947, 1949, 1951. Washington, Supt. of Documents, 1948, 1949, 1951. 3 vols. 11½″.

West Indian Conference. Statistical abstract to the West Indian Conference, fifth session . . . compiled by the Statistical Unit, Research Branch Central Secretariat, Caribbean Commission. Port-of-Spain, Trinidad, 1952. 2 vols. 8½″ × 14″.

World Health Organisation and United Nations Educational, Scientific and Cultural Organisation. World medical periodicals. 1953. xvi, 237p. 9½″. 12*s.* 6*d.* In English, French and Spanish.

Yugoslavia. *Federal Statistical Office.* Final results of the population census of March 15th, 1948. Vol. IV. Population by school qualifications. Vol. VIII. Female population by number of live-born children. Beograd, 1952. 2 vols. 11¼″.

II.—AUTHORS AND MISCELLANEOUS.

Berne, University of. 50 Jahre Mathematisch-Versicherungs-Wissenschaftliches Seminar der Universität Bern 1902–1952: Gedenkfeier 1952. Berne, [1953]. 44p. 9″.

Bowden (B. V.), *editor.* Faster than thought: a symposium on digital computing machines. London, Pitman, 1953. xix, 416p. illus. 9″. 35*s.*

Boyd (D. A.). The effect of seed rate on yield of cereals. *Empire J. Exp. Agric.* (1952), **20**, 115–122. 9¼″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Boyd (D. A.) & Dyke (S. V.). The place of statistics in field experiments. *N.A.A.S. Quart. Rev.* (1952), **Spring**, no.15. [8] p. 8½″.

Boyd (D. A.) & Ellison (W.). Possibilities of marginal land reclamation: some results of a survey in England and Wales. *J. R. Agric. Soc.* (1952), **113**, 26–43 l. 9¾″.

Brandt (Karl). The future of agricultural exports. Seattle, Wash., American Farm Bureau Federation, 1952. 15p. 8½″. Presented by the author.

British Commonwealth Statisticians. *Conference 1951.* Papers presented at the Conference of British Commonwealth Statisticians 1951. Comprising papers contributed by countries represented at the Third Conference of British Commonwealth Statisticians held at Canberra, Australia, from 12th to 23rd November, 1951. Canberra, Commonwealth Government Printer. iv, 330p. 13″.

British Transport Commission. Bristol on the move: a travel survey. London, British Transport Commission, 1953. 46p. illus. 9″. 10*s.* 6*d.*

Brownlee (K. A.) *& others.* The up-and-down method with small samples. *J. Amer. Statist. Ass.* (1953), **48**, 262–277. 9¼″. Presented by the author.

Cadwell (J. H.). The statistical treatment of mean deviation. O.B. Statistics Group Notes 4/53 (1953). [1]. 6p. 8″ × 13″. Presented by the author.

Church (B. M.). Recent trends in fertilizer practice in England and Wales. Part I. The national position. *Empire J. Exp. Agric.* (1952), **20**, 249–256. 9¼″. Part II. The use of fertilizers on cereals, root crops, and grassland. *Empire J. Exp. Agric.* (1952), **20**, 257–270. 9¼″.

Clarke (L. Harwood). A note book in pure mathematics. London, Heinemann, 1953. xii, 184p. 7¾″. 8*s.* 6*d.*

Cotter (Helen) *& others.* The variation from day to day in the haemoglobin value of young women. *Aust. Ann. Med.* (1953), **2**, 99–102. 10½″.

Gini (Corrado). Asimmetria e anormalità delle distribuzioni statistiche. *Metron* (1951), **16**, no. 3–4, 76p. 9¼″.

L'assimilazione fiscia degli immigrati. *Genus* (1952), **9**, 8p. 9¼″.

Caractères des plus récents dévéloppements de la méthodologie statistique. *Statistica* (1951), **11**, 11p. 9½″.

Combinations and sequences of sexes in human families and mammal litters: a review of literature with comments and some new results. *Acta Genet.* (1951), **2**, 220–244. 9¾″.

Della relazione tra differenza media con ripetizione e scostamento semplice medio dalla mediana. *Metron* (1951), **16**, no. 3–4, 3p. 9½″.

Del passaggio dall'indice di variabilità di un campione all'indice di variabilità della massa. *Metron* (1951), **16**, no. 3–4, 5p. 9¾″.

Démographie et sociologie. Notes du cours donné á la Faculté des Lettres, recueillies et resumées par Haydar Izzet Furgac. Istanbul, 1952. 54p. 9½″. 100*kr.* (Istanbul Univ. Yayinlarindar no. 528.) Bibliog. p.42–54.

Estensione della teoria della dispersione e della connessione a serie di grandezze assolute. *G. Ist. ital. Attuari* (1952), **15**, 4–24. 9¾″.

L'evoluzione del concetto di media. *Metron* (1952), **16**, no. 3–4, 26p. 9½″.

Intorno all'uso dei modelli nelle scienze, e in particolare nella scienza economica. *Riv. Pol. Econ.* (1953), **43**, 21p. 9¾″.

Ludologia. *Genus* (1952), **11**, 7p. 9¼″.

Major and minor problems in the estimates of national income. *Rev. Int. Statist. Inst.* (1952), 18–27p. (10p.) 10½″.

The means of samples. *Proc. Int. Statist. Conf.* (1947), **3**, 258–271. 9½″.

Old and new problems about national income and national wealth. *Banca Nazionale del Lavoro Quart. Rev.* (1952), 24p. 11″.

On statistical relations and their inversions. *Proc. Int. Statist. Conf.* (1947), **3**, 759–762. 9½″.

The plans for the development of depressed areas and the supremacy of the western world. *Banca Nazionale del Lavoro Quart. Rev.* (1951), 7p. 11″.

Population statistics in primitive tribes ; ... reprinted from Summaries of a lecture delivered at the Statistical Seminar held at Calcutta, December 1951. The Hague, International Statistical Institute, 1952. 16–24p. 11¾″.

Problemi sul reddito nazionale. *Riv. Pol. Econ.* (1952), **42**, 14p. 9½″.

Ricchezza e reddito (messa a punto di concetti). *Metroeconomica* (1952), **4**, 116–128. 9½″.

The statistical bases of diagnosis and prognosis. *Acta Genet.* (1952), **3**, 280–304. 9¾″.

Studi sul genio. *Genus* (1952), **9**, 9p. 9¼″.

La surface et le fond des problèmes démographiques internationaux. *Metron* (1952), **16**, no. 3–4, 14p. 9½″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Ulteriori considerazioni sull' asimmetria delle distribuzioni statistische. *Metron* (1952), **16**, no. 3–4. 25p. 9½″. Presented by the author.

Hays (Samuel). An outline of statistics. 4th ed. London, Longmans, Green, 1953. vii, 289p. 7¼″. 10*s.* 6*d.*

Healy (M. J. R.). The analysis of lattice designs when a variety is missing. *Emp. J. Exp. Agric.* (1952), **20**, 220–226. 9¼″.

A table of Abbott's correction for natural mortality. *Ann. Appl. Biol.* (1952), **39**, 211–212. 10½″.

Hickman (W. Braddock). The volume of corporate bond financing since 1900 ... a study by the National Bureau of Economic Research, New York. Princeton, Princeton University Press, 1953. xxxi, 429p. illus. 9″. $7.50. (N.B.E.R. Financial Research Program: Studies in Corporate Bond Financing no. 1.)

Holmes (R. L. A.). Statistics for professional students. 3rd ed. London, Pitman, 1953. x, 165p. illus. 8½″. 15*s.* Bibliog. p. 159.

Hood (William C.) & Koopmans (Tjalling C.), *editors.* Studies on econometric method: by Cowles Commission Staff Members. New York, Wiley, 1953 (London, Chapman & Hall). xix, 323p. 9″. 44*s.* (Cowles Commission for Research in Economics Monograph 14.) Bibliog. p.305–310.

Jackson (Gilbert E.). Wages rates and the growth of output per man hour. Toronto, Gilbert Jackson & Associates, 1953. 24p. 9¾″.

Kemsley (W. F. F.). Change in body weight from 1943–1950. *Ann. Eugen.* (1953), **18**, 22–42. 10¾″.

Kuczynski (Jürgen). Die Geschichte der Lage der Arbeiter in Deutschland von 1789 bis in die Gegenwart, Band II. Erster teil 1933 bis Mai 1945. Dritte verbesserte Aufl. Berlin, Tribüne, 1953. 311p. 8¼″. (Die Geschichte der Lage der Arbeiter unter dem Kapitalismus.) Presented by the author.

Lancaster, (H. O.). An amoebic survey of Australian soldiers during the second world war. *Med. J. Aust.* (1953), p.552. 2p. 11″.

The mortality from violence in Australia. *Med. J. Aust.* (1952), p. 649. 8p. 10½″.

The mortality in Australia from cancers peculiar to the male. *Med. J. Aust.* (1952), p.41. 4p. 10¾″.

The mortality in Australia from measles, scarlatina and diphtheria. *Med. J. Aust.* (1952), p. 272. 7p. 10½″.

The mortality in Australia from typhus, typhoid fever and infections of the bowel. *Med. J. Aust.* (1953), p.576. 4p. 11″.

Statistical control of counting experiments. *Biometrika* (1952), **39**, 419–422. 10¾″.

Lancaster (H. O.) & Pickering (H.). The incidence of births of the deaf in New Zealand. *N.Z. Med. J.* (1952), **51**, 184–189. 6p. 9½″. Presented by the author.

Lindley (D. V.) & Miller (J. C. P.). Cambridge elementary statistical tables. C.U.P., 1953. 35p. 11″. 5*s.*

Moran (P. A. P.). The statistical analysis of the Canadian lynx cycle: I. Structure and prediction. *Aust. J. Zoology* (1953), **1**, 163–173. 9½″. Presented by the author.

North Carolina, Consolidated University of. Institute of Statistics. The use of analysis of covariance and balancing in analytical surveys; by Bernard G. Greenberg. *Amer. J. Publ. Hlth.* (1953), **43**, 692–699. 9½″. (Repr. Ser. 34.)

Dominance of genes controlling quantitative characters in maize; by C. O. Gardner, P. H. Harvey, R. E. Comstock and H. R. Robinson. *Agron. J.* (1953), **45**, 186–191. 10¾″. (Repr. Ser. 35.)

Design and analysis of triangular singly linked blocks; by K. R. Nair. *Biometrics* (1953), **9**, 141–156. 9″. (Repr. Ser. 36.)

On the construction of group divisible incomplete block designs; by R. C. Rose, S. S. Shrikhande and K. N. Bhattacharya. *Ann. Math. Statist.* (1953), **24**, 167–185. 9½″. (Repr. Ser. 37.) Presented by the Institute.

Paradine (C. G.) & Rivett (B. H. P.). Statistics for technologists. London, English Univ. Press, 1953. vii, 288p. 8½″. 25*s.*

Patterson (H. D.). The analysis of the results of a rotation experiment on the use of straw and fertilizers. *J. Agric. Sci.* (1953), **43**, 77–88. 10″.

Rao (C. Radhakrishna). Methods of scoring linkage data giving the simultaneous segregation of three factors. *Heredity* (1950), **4**, 37–59. 9¾″.

Statistical inference applied to classificatory problems. Part II: the problem of selecting individuals for various duties in a specified ratio. *Sankhyā* (1951), **11**, 107–116. 11″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The applicability of large sample tests for moving average and autoregressive schemes to series of short length—an experimental study. Part 3. The discriminant function approach in the classification of time series. (Part III of statistical inference applied to classificatory problems.) *Sankhyā* (1951), **11**, 255–272. 11″.

Discriminant functions for genetic differentiation and selection. (Part IV of statistical inference applied to classificatory problems.) *Sankhyā* (1953), **12**, 229–246. 11″.

Staples (Ronald), *editor.* "Taxation" key to income tax and surtax ... Finance Act ed. 1953. 37th ed. London, Taxation Publishing Co., 1953. 222p. 7*s.* 6*d.*

Stigler (George J.). The theory of price. Rev. ed. New York, Macmillan, 1952. vii, [ii], 310p. 8¼″. 28*s.*

Solutions to problems in The Theory of Price. New York, Macmillan, 1946. [iv], 33p. 9″.

Taylor (Wallis). Cohort analysis of fertility in England and Wales, 1939–1950. *Brit. J. Soc. Med.* (1952), **6**, 226–244. 9¾″.

Timber Development Association. T.D.A. statistical year book 1952. 2nd ed. London, T.D.A., 1953. 34p. 10″.

Vinci (Felice). Statistica ed economica nella nostra enciclopedia matematica. Milan, 1953. 25p. 9¾″. (Univ. degli Studi di Milano. Ist. Sci. Econ. e Statist. Quaderni 17.)

Winkler (Wilhelm). Typenlehre der Demographie (reine Bevölkerungstypen). Wien, R. M. Rohner, 1952. 160p. 9½″. Presented by the author.

Working (Holbrook). Futures trading and hedging. *Amer. Econ. Rev.* (1953), **43**, 314–343. 9¼″.

Woytinsky (W. S.) & Woytinsky (E. S.). World population and production: trends and outlook. New York, Twentieth Century Fund, 1953. lxxii, 1268p. 10″. $12.

Yates (Frank). George Udny Yule 1871–1951. *Obit. Not. Roy. Soc.* (1952), **8**. 309–323. 10″.

Sampling methods for censuses and surveys. 2nd ed. London, Griffin, 1953. xvi, 401p. 8¾″. 38*s.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Vol. 117.] [Part II

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART II, 1954.

Cinemas and Cinema-going in Great Britain

By H. E. Browning and A. A. Sorrell

[Read before the Royal Statistical Society, January 27th, 1954,
Mr. E. C. Fieller, Vice-President, in the Chair]

I. Introduction

It is fitting, in presenting some of the facts which govern and illumine the state of the cinema industry in this country, that acknowledgment should first be made to the work of the late Simon Rowson, who gave in a paper read to this Society in December, 1935, the first comprehensive survey of the industry, showing its size, structure and achievements in 1934. When we were asked in 1949 to find out what we could about cinemas and films, Rowson's results were still the only source for a balanced review and they furnished an invaluable guide to the sort of approach to be adopted for a new survey.

That the time for this was overdue was clear from the comment in the report of the Plant Committee on the Distribution and Exhibition of Cinematograph Films that "we have been hampered in our examination of the structure of the industry by the absence of adequate statistics". An attempt has been made to remedy this deficiency in a series of inquiries into the several branches of the industry, the main results of which have been published since the beginning of 1950 in the *Board of Trade Journal*. On the exhibition side these inquiries have been confined to the ordinary public cinemas in Great Britain showing 35 mm. films other than those operated by the armed forces. Returns have been required each quarter under the Statistics of Trade Act, 1947, and the response rate has always been more than 99 per cent. The object of the present paper is to set the results in perspective and to bring out some aspects of the figures collected which it has not been possible to include in the limited space available in the *Board of Trade Journal*. Questions on different aspects of the cinema industry were asked at different times, so that our tables refer to a variety of periods. Estimation has been necessary for the consideration of the combined effects of various factors, but we do not think this has led to serious errors.

The industry in the post-war period presents some interesting contrasts with the picture drawn by Rowson in 1935. War had an effect on it different from what might have been expected, and it has been followed by years of disillusion and uncertainty. Yet these post-war difficulties have given rise to experiment and innovation in two continents, with 3-dimension films, cinemascope, cinerama and the rest of a bewildering array of technical devices competing for the world market; while the growth of television provides a challenge to the "silver screen" which is being eagerly taken up through both competition and co-operation.

Anxiety amid the glitter of this trade is after all no new thing. One of the problems that Rowson considered in 1935 was that of redundancy in the provision of cinemas and cinema seats. He was apparently concerned as to whether the limit of admissions was approaching. He need not have worried. The figures in Table 1 show that, so far from levelling off, the industry was approaching a period of phenomenal growth in public patronage. Admissions in 1934 represented 20 visits a year to the cinema for every member of the population, but in 1946 this ratio was 34, 70 per cent. higher; although this peak was followed by a sharp set-back in the following year. Against this background, a gradual fall to 27 visits per head in 1952 may be viewed with some concern but hardly with alarm.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1

Estimates of Cinema Admissions and Gross Takings, 1934–1952

Calendar Year	*Admissions (million)*	*Gross Takings (£ million)*	*Entertainment Duty (£ million)*	*Payments to the British Film Production Fund (£ million)*	*Net Takings (£ million)*	*Average Admission Price (Pence)*
1934	903	38·8	6·4	—	32·4	10·3
1935	907	38·7	5·8	—	32·9	10·2
1936	917	38·6	5·2	—	33·4	10·1
1937	946	39·9	5·4	—	34·5	10·1
1938	987	41·5	5·5	—	36·0	10·1
1939	990	41·7	5·6	—	36·1	10·1
1940	1,027	44·9	6·7	—	38·2	10·6
1941	1,309	65·0	12·8	—	52·2	11·9
1942	1,494	87·2	23·2	—	64·0	14·0
1943	1,541	103·5	34·7	—	68·8	16·1
1944	1,575	111·8	39·7	—	72·1	17·0
1945	1,585	114·2	40·8	—	73·4	17·3
1946	1,635	118·3	42·4	—	75·9	17·4
1947	1,462	105·4	37·7	—	67·7	17·3
1948	1,514	108·8	38·8	—	70·0	17·2
1949	1,430	103·3	36·5	—	66·8	17·3
1950(*a*)	1,396	105·2	36·8	0·4	68·0	18·1
1951(*a*)	1,365	108·3	38·3	2·1	68·9	19·0
1952(*a*)	1,312	109·9	38·1	2·9	68·9	20·1

Based on data supplied by H.M. Customs and Excise.

(*a*) Actual figures.

In this table the figures for 1934 represent a revision of those given by Rowson based on new information about the distribution of tickets which could be used for any kind of entertainment and not only cinemas. This information suggests that a smaller proportion of these tickets was used for cinemas at that time than Rowson assumed. The amount of duty collected by this means does not seem likely to have exceeded about £1,200,000 as against the original estimate of £1,580,000. This corresponds to gross takings of about £7,450,000 using Rowson's own formula* and, added to the takings in houses paying duty on the basis of certified returns (i.e., those which account direct to H.M. Customs and Excise each week for the tax payable on their admissions), produces a total of gross box-office takings of £38,800,000 in place of the original estimate of £41,120,000. The number of admissions in 1934 can be put at 903 million compared with Rowson's figure of 963 million.

From the end of 1934 the figures of all entertainment duty received in respect of cinema admissions were extracted separately and, as a result of sample analyses which were made from time to time, the proportion of gross takings represented by duty and the average price of admission were calculated. These rates were of course affected by alterations in the rates of duty; due allowance has been made for this throughout and also for admissions on which no tax was paid because of exemption from duty of low-priced tickets and, since 1947, of certain cinemas in rural areas. For the years 1950 to 1952 the figures in the table are taken from the official quarterly cinema surveys.

The war-time expansion and post-war contraction in cinema business shown in Table 1 was not confined to this country. In the United States, for example, box office takings increased from $518 million in 1934 to $1,512 million in 1946, nearly three times as much, part of the increase being accounted for by an increase in the Federal admission tax from 10 per cent. to 20 per cent. in 1943. (The proportionate increase in takings in Britain over the same period was roughly equal to that in America but the increase in the rate of duty was greater). By 1952, takings at

* Rowson applied a multiplier of 6 to the duty paid on certified returns, and of 6·2 to other duty payments, as representing the incidence of duty; the result was divided by the estimated average price to give the number of admissions.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

conventional cinemas had declined to probably less than $1,000 million, or by about a third since 1946; but nearly $250 million was taken in 1952 at drive-in theatres, which are a post-war development. We have not been able, from the information available to us, to estimate how far drive-ins have prevented a greater decline in total takings and how far they have drawn business from conventional halls; but total takings were about a sixth less in 1952 than in 1946, a decline generally attributed to the effect of competition from television.

The increase shown in the table is particularly noteworthy in the earlier part of the war, the number of admissions increasing by 50 per cent. between 1940 and 1943. The chief factor in this rise was almost certainly the growing financial prosperity of the mass of the population, all employable people being engaged in remunerative employment, and therefore in a position to relieve the tedium of war-time existence by spending on frequent visits to the cinema the money for which few competing uses could then be found. When the war ended admissions jumped again to the phenomenal level of 1946, but thereafter there has been a decline except for 1948. From 1949 to 1951 the decline in admissions was at the steady but not precipitate rate of about 2 per cent. a year, and could be viewed as an indication of the gradual elimination of inflationary tendencies from the economy—money in the pockets of the people has been more and more limited in amount, and the competing claims on it of other forms of expenditure have grown.

In 1952, however, the rate of decline doubled. To a considerable extent, as will be shown, this further contraction has been due to the spread of television and has caused some film people to cast anxious glances at the agonies of American cinemas in the squeeze of their rival. But we shall see that the cases are in reality rather different. The recent decline in cinema attendances in Britain has not much exceeded that in other forms of entertainment as is shown by the estimates in Table 2. (The figures for cinemas differ from those in Table 1 which include non-taxable admissions.)

TABLE 2

Estimated Admissions and Gross Takings for Taxable Entertainments, 1950–1952

	Admissions (million)			*Gross Takings (£ million)*		
	1950	1951	1952	1950	1951	1952
Cinemas	1,333	1,240	1,204	102·8	103·9	106·5
Theatres and Music Halls	84	82	83	17·9	17·8	18·7
Football	84	77	81	7·4	7·6	8·2
Cricket	4	5	4	0·4	0·5	0·4
Horse racing	6	6	6	3·6	3·5	3·4
Dog racing	30	27	25	3·4	3·1	2·9
Other racing and sport	28	22	19	3·4	3·3	2·7
Other entertainments	42	39	36	4·5	4·6	4·0
	1,611	1,498	1,458	143·3	144·3	146·8

Based on data supplied by H.M. Customs and Excise.

The really striking thing about Table 2, however, is the evidence it gives of the dominant position of cinemas in the entertainment world. In each of the years shown they account for no less than 83 per cent. of all taxable admissions to entertainment. No doubt this is not unconnected with the fact that the average price of admissions to cinemas is less than that for any other form of popular entertainment. In 1935 Rowson described the cinema as one of the sociological wonders of the modern world in view of the luxurious amenities which could be enjoyed for an admission of usually less than one shilling. The price has gone up since then but the average has less than doubled. Rowson's judgment still holds true, for the cinema still offers, even to the poor, exciting or soothing entertainment in comfortable surroundings as an escape from the hard and humdrum world. Indeed, Britain is the land of the cinema to a far greater extent even than America. Table 3 shows the number of admissions per head per year in countries with the highest rates.

The high rates shown in this table for English-speaking countries is without doubt due, in the main, to the great flow of films in English, especially from Hollywood; and the extremely high rate for Britain is due to the high concentration of population in this island so that a cinema can be provided within comfortable reach of nearly every household.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Cinema Attendance in Principal Countries

Country	*Year*	*Number of Admissions*	
		Total millions	*Per head*
Great Britain . .	1950	1,396	28
United States . .	1949	3,500	23
New Zealand . .	1949(*a*)	36	19
Canada . . .	1950	242	17
Australia . . .	1948(*b*)	130	17
Italy	1950	654	14
Belgium . . .	1950	118	14
Denmark . . .	1949	50	12
German Federal Republic	1949	525	11
France	1950	367	9
Norway . . .	1950	31	9
Japan	1950	630	8

From UNESCO (1952) Basic Facts and Figures.
(*a*) Year ended March 31st, 1950.
(*b*) Year ended June 30th, 1949.

The analysis of trends in a social activity of such proportions as we have indicated is a matter of great interest. Before we embark upon this, however, and try to show the effect of various influences upon the revenues and costs of the industry, we must first consider the nature and distribution of the palaces in which this nearly universal entertainment is provided and the structure of their ownership and control.

II. Cinemas, Seats and Programmes

Although in 1934, when Rowson described the exhibition industry, few, if any, cinemas were showing silent films, the effects on the structure of the industry of the technical revolution it had just accomplished had far from spent themselves. Two factors in particular were bringing about a fundamental change in the structure of the industry. There was first the advent of the large, comfortable and imposing "super cinema" with its obvious attractions over the cinema built to accommodate the smaller audiences of the silent days, having few amenities and sometimes inadequate equipment for handling talkies. The decline of these smaller obsolete halls led to talk of redundancy in the industry. Secondly, the substantial finance required for the new cinemas was provided by a relatively small number of companies, some of which were able to extend their control over a large number of cinemas so establishing the great circuits. In 1934 there was one seat for every 10·5 persons, or one for every 8·9 persons over 15 years of age. From the outbreak of war to the beginning of 1951 there were virtually no new cinemas built. Apart, therefore, from the conversion of some theatres, any addition to the number of cinemas ceased five years after Rowson's description of the industry, although there were, of course, losses due to voluntary closing or to bomb damage, etc. At the beginning of 1951 there was one seat for every 11·6 persons, or one for every 9·0 persons over 15. The number of seats, therefore, in relation to the adult population was very much the same as it was 16 years before.

TABLE 4

Distribution of Cinemas by Size, 1934 and 1951

Size of Cinema (Number of Seats)	*Cinemas*				*Seats*				*Proportionate Change in Number of Seats 1934–1951*
	1934		1951		1934		1951		
	Number	*Per cent.*	*Number*	*Per cent.*	*Thousands*	*Per cent.*	*Thousands*	*Per cent.*	*Per cent.*
Up to 500 .	901	20·9	1,062	23·1	371	9·6	388	9·2	+ 4·3
501–1,000 .	2,184	50·8	1,935	42·1	1,660	42·8	1,437	34·9	−13·4
1,001–1,500 .	764	17·7	926	20·1	939	24·3	1,110	26·3	+18·2
1,501–2,000 .	307	7·1	469	10·2	537	13·9	803	19·0	+49·5
Over 2,000.	149	3·5	205	4·6	365	9·4	483	11·5	+32·9
Total .	4,305	100·0	4,597	100·0	3,872	100·0	4,221	100·0	+ 9·0

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

These figures, however, conceal a considerable change in the size structure of cinemas and Table 4 compares the number of cinemas and seats classified by size of cinema in the two years. As a proportion of the total the smallest cinemas have held their own, both in terms of numbers and of seats, and it has been the small to medium cinemas with a seating capacity between 501 and 1,000 that have suffered most. The increase in the number of cinemas and seats occurred mainly in cinemas with 1,501 to 2,000 seats; the number of seats available in these cinemas increased by a half, and represented a fifth of the total compared with a seventh in 1934. Fewer additions were made to the largest cinemas (with over 2,000 seats) although the number of seats in these cinemas increased by nearly a third. The extent of the growth of the larger and the decline of the smaller cinemas can conveniently be shown by the fact that cinemas with over 1,000 seats represented 56·9 per cent. of all seats in 1951 compared with 47·6 per cent. in 1934. The result has been an increase in the average size of cinemas from 900 to 918 seats. The explanation for the relatively favourable position of the smallest cinemas is probably that many of them existed, and have survived, in rural areas where the building of a larger cinema by a potential competitor has not been an economic proposition. It has, no doubt, been the small to medium cinemas in the urban areas which have suffered most from the competition of the modern luxury cinemas, and have, in many cases, succumbed.

It is not possible to make quite so detailed a comparison of the changes in the regional distribution of cinemas between the two years, since the information for 1951 is classified according to the Registrar-General's Standard Regions while Rowson used his own regional classification. Table 5 shows, however, that the number of seats available in Scotland increased much more than in England and Wales although even in 1934 Scotland was better served than the rest of Great Britain.

TABLE 5

Distribution of Cinemas and Seats by Country, 1934 and 1951

	Cinemas		*Seats*		*Proportionate Change in Number of Seats*	*Persons per Seat*	
	1934 (*number*)	1951 (*number*)	1934 ('000)	1951 ('000)	1934–1951 (*Per cent.*)	1934 (*number*)	1951 (*number*)
England	3,462	3,642	3,118	3,373	+ 8·2	12·1	12·2
Wales	321	352	243	256	+ 5·3	10·7	10·1
Scotland	522	603	511	591	+15·7	9·5	8·6
Total	4,305	4,597	3,872	4,221	+ 9·0	11·7	11·6

We have been able, by analysing the exhibitors' returns for the first quarter of 1951, to examine in much more detail the geographical distribution of cinemas in Great Britain. We have attempted to determine the number of cinemas and seats in all county boroughs, municipal boroughs and urban districts (in Scotland burghs) with a population of over 50,000 according to the 1951 Census of Population. The address given in the quarterly return was used to classify cinemas to towns, but in many cases the postal address was insufficient to determine whether the cinema was within a particular administrative area. Normally, however, the address gave the district within the postal area and it was possible in most cases, by reference to a large-scale map or to the General Register Office, to determine the administrative area in which the cinema was situated. We believe that any inaccuracies in the town classification are only slight. In many cases, the publication of the results of this analysis for towns with a population of under 100,000 would result in the disclosure of information relating to individual cinemas and we therefore confine the details of particular towns given in this paper to those with a population over this figure.

Table 6 shows the relationship between cinemas, and seats, and the population for most towns with a population of 100,000 or more, only 6 being omitted for disclosure reasons. It also shows the broad results for towns of over 100,000, and between 50,000 and 100,000 inhabitants and for the rest of the area for each of the Standard Regions. This broader picture is often more meaningful as cinemas serve to varying extents a population outside the limits of the town in which they are situated, particularly where these towns are arbitrary administrative divisions in a

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 6

Cinema Admissions and Takings, April, 1950–March, 1951

	Population ('000)	*Cinemas* (*Number*)	*Seats* ('000)	*Population per Seat* (*Number*)	*Admissions* ('000)	*Admissions per Seat* (*Number*)	*Admissions per Person* (*Number*)	*Gross Takings* (£'000)	*Tax* (£'000)	*Net Takings* (£'000)	*Film Hire* (£'000)	*Exhibitors' Share* (£'000)	*Average Price of Admission* (*Pence*)	*Film Hire as Proportion of Net Takings* (*Per cent.*)	*Exhibitors' Share per Seat* (£)
Scotland															
Glasgow	1,090	104	148·0	7·4	56,042	379	51	3,426	1,080	2,345	817	1,529	14·7	34·8	10·3
Edinburgh	467	36	49·8	9·4	17,280	347	37	1,335	491	844	322	522	18·5	38·2	10·5
Aberdeen	183	17	23·5	7·8	8,108	345	44	561	193	368	126	242	16·6	34·2	10·3
Dundee	177	25	27·5	6·4	7,919	288	45	554	195	359	133	226	16·8	37·0	8·2
Total towns over 100,000	1,916	182	248·8	7·7	89,349	359	47	5,875	1,959	3,916	1,398	2,518	15·8	35·7	10·1
Total towns 50–100,000	238	25	34·8	6·8	12,096	348	51	799	274	525	191	334	15·9	36·4	9·6
Total remainder of region	2,942	396	307·8	9·6	84,285	274	29	5,427	1,753	3,673	1,394	2,279	15·5	38·0	7·4
Total Scotland	5,096	603	591·4	8·6	185,730	314	36	12,101	3,987	8,114	2,983	5,131	15·6	36·8	8·7
Northern															
Newcastle-on-Tyne	292	34	36·2	8·1	14,649	405	50	1,118	400	718	262	457	18·3	36·5	12·6
Sunderland	182	15	16·4	11·1	8,250	503	45	587	209	378	138	240	17·1	36·5	14·6
Middlesbrough	147	12	13·3	11·1	6,363	478	43	428	146	283	103	180	16·1	36·4	13·5
Gateshead	115	15	16·7	6·9	5,655	339	49	330	104	226	81	145	14·0	35·8	8·7
South Shields	107	12	12·4	8·6	5,157	416	48	343	116	227	81	146	16·0	35·7	11·8
Total towns over 100,000	842	88	95·0	8·9	40,074	422	48	2,806	974	1,832	664	1,168	16·8	36·2	12·3
Total towns 50–100,000	366	38	41·7	8·8	16,706	401	46	1,190	418	772	281	491	17·1	36·4	11·8
Total remainder of region	1,932	297	192·4	10·0	59,481	309	31	3,348	960	2,388	869	1,519	13·5	36·4	7·9
Total Northern	3,140	423	329·1	9·5	116,261	353	37	7,344	2,351	4,992	1,815	3,178	15·2	36·4	9·7
East and West Ridings															
Sheffield	513	50	51·1	10·0	20,074	393	39	1,277	421	856	307	549	15·3	35·9	10·7
Leeds	505	62	58·1	8·7	22,280	383	44	1,430	470	961	334	627	15·4	34·8	10·8
Kingston-upon-Hull	299	25	31·0	9·6	11,610	375	39	797	272	526	185	341	16·5	35·2	11·0
Bradford	292	38	36·5	8.0	11,864	325	41	787	263	524	175	350	15·9	33·4	9·6
Huddersfield	129	23	19·2	6·7	4,923	256	38	375	138	237	91	146	18·3	38·4	7·6
York	105	8	9·6	10·9	3,399	354	32	288	110	179	65	113	20·3	36·3	11·8
Total towns over 100,000	1,844	206	205·5	9·0	74,150	361	40	4,956	1,673	3,282	1,157	2,125	16·0	35·3	10·3
Total towns 50–100,000	560	68	72·1	7·8	25,243	350	45	1,833	648	1,184	442	742	17·4	37·3	10·3
Total remainder of region	1,693	185	127·5	13·3	38,863	305	23	2,365	752	1,614	545	1,068	14·6	33·8	8·4
Total East and West Ridings	4,096	459	405·1	10·1	138,256	341	34	9,153	3,074	6,081	2,144	3,936	15·9	35·3	9·7
North-Western															
Liverpool	790	77	85·7	9·2	36,603	427	46	2,422	821	1,601	511	1,091	15·9	31·9	12·7
Manchester	703	93	100·8	7·0	35,286	350	50	2,349	785	1,565	537	1,028	16·0	34·3	10·2
Salford	178	20	19·8	9·0	6,948	351	39	360	102	258	92	166	12·4	35·7	8·4
Bolton	167	20	23·5	7·1	7,271	309	44	462	150	312	109	203	15·2	34·9	8·6
Blackpool	147	19	27·0	5·4	7,308	271	50	650	248	402	161	241	21·3	40·0	8·9
Birkenhead	142	12	14·3	9·9	5,287	370	37	408	148	260	91	169	18·5	35·0	11·8
Stockport	142	19	19·4	7·3	5,741	296	40	382	131	251	97	154	16·0	38·6	7·9
Oldham	121	14	18·9	6·4	5,607	297	46	354	116	238	84	154	15·2	35·3	8·1
Preston	119	17	15·4	7·7	6,303	409	53	395	130	265	97	168	15·0	36·6	10·9
Blackburn	111	14	14·6	7·6	3,893	267	35	257	87	171	67	103	15·8	39·2	7·1
St. Helens	110	10	8·5	12·9	3,990	469	36	294	106	188	65	123	17·7	34·6	14·5
Wallasey	101	11	9·7	10·4	3,423	353	34	214	68	145	51	95	15·0	35·2	9·8
Total towns over 100,000	2,832	326	357·6	7·9	127,660	357	45	8,547	2,891	5,655	1,961	3,695	16·1	34·7	10·3
Total towns 50–100,000	903	102	102·0	8·9	34,030	334	38	2,412	847	1,565	573	992	17·0	36·6	9·7
Total remainder of region	2,710	287	219·6	12·3	65,822	300	24	4,236	1,403	2,834	1,046	1,789	15·4	36·9	8·1
Total North-Western	6,445	715	679·2	9·5	227,512	335	35	15,194	5,141	10,054	3,580	6,475	16·0	35·6	9·5

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 6—*continued.*

	Population ('000)	*Cinemas* (*Number*)	*Seats* ('000)	*Population per Seat* (*Number*)	*Admissions* ('000)	*Admissions per Seat* (*Number*)	*Admissions per Person* (*Number*)	*Gross Takings* (£'000)	*Tax* (£'000)	*Net Takings* (£'000)	*Film Hire* (£'000)	*Exhibitors' Share* (£'000)	*Average Price of Admission* (*Pence*)	*Film Hire as Proportion of Net Takings* (*Per cent.*)	*Exhibitors' Share per Seat* (£)
Northern regions															
Total towns over 100,000	7,434	802	906·9	8·2	331,233	365	45	22,183	7,498	14,685	5,179	9,506	16·1	35·3	10·5
Total towns 50–100,000	2,067	233	250·6	8·2	88,075	351	43	6,234	2,187	4,047	1,488	2,559	17·0	36·8	10·2
Total remainder of area	9,277	1,165	847·3	10·9	248,451	293	27	15,375	4,868	10,509	3,855	6,655	14·9	36·7	7·9
Total Northern Regions	18,777	2,200	2,004·8	9·4	667,759	333	36	43,792	14,553	29,241	10,522	18,720	15·7	36·0	9·3
North Midland															
Nottingham	306	37	39·2	7·8	13,166	336	43	956	336	620	204	416	17·4	32·9	10·6
Leicester	285	25	30·3	9·4	10,397	343	36	747	262	484	171	313	17·2	35·3	10·3
Derby	141	15	17·0	8·3	5,199	306	37	423	158	265	96	169	19·5	36·2	9·9
Northampton	104	10	9·5	10·9	3,001	316	29	242	88	153	55	98	19·4	35·9	10·3
Total towns over 100,000	837	87	96·0	8·7	31,763	331	38	2,368	845	1,523	527	996	17·9	34·6	10·4
Total towns 50–100,000	391	40	40·1	9·8	14,829	370	38	1,174	432	742	255	487	19·0	34·4	12·1
Total remainder of region	2,150	205	140·2	15·3	37,228	266	18	2,726	928	1,798	607	1,192	17·6	33·8	8·5
Total North Midland	3,378	332	276·3	12·2	83,820	303	25	6,267	2,205	4,062	1,388	2,675	17·9	34·2	9·7
Midland															
Birmingham	1,112	82	96·5	11·5	37,396	388	34	2,704	947	1,757	594	1,162	17·4	33·8	12·0
Stoke-on-Trent	275	27	29·9	9·2	10,358	346	38	724	255	469	168	301	16·8	35·8	10·1
Coventry	258	19	21·2	12·2	7,041	332	27	612	239	373	129	244	20·9	34·6	11·5
Wolverhampton	163	13	15·2	10·7	5,479	360	34	454	171	283	97	186	19·9	34·3	12·2
Walsall	115	9	10·5	11·0	3,305	315	29	264	99	165	58	107	19·2	35·2	10·2
Total towns over 100,000	1,923	150	173·3	11·1	63,579	367	33	4,757	1,711	3,046	1,047	2,000	18·0	34·4	11·5
Total towns 50–100,000	532	46	46·5	11·4	15,171	326	29	1,167	426	741	265	476	18·5	35·8	10·2
Total remainder of region	1,967	172	125·5	15·7	37,015	295	19	2,875	1,018	1,858	649	1,208	18·7	34·9	9·6
Total Midland	4,422	368	345·3	12·8	115,765	335	26	8,799	3,154	5,645	1,961	3,684	18·2	34·7	10·7
Eastern															
Southend	152	13	16·8	9·0	4,781	285	31	374	138	236	81	155	18·8	34·3	9·2
Norwich	121	11	11·9	10·2	3,876	326	32	326	122	204	72	133	20·2	35·3	11·2
Luton	110	5	7·4	14·9	2,825	382	26	262	102	160	59	101	22·3	36·9	13·6
Other towns over 100,000	209	6	9·3	22·5	3,266	351	16	292	113	179	67	112	21·5	37·4	12·0
Total towns over 100,000	592	35	45·4	13·0	14,748	325	25	1,254	475	779	278	501	20·4	35·7	11·0
Total towns 50–100,000	486	42	46·9	10·4	15,375	328	32	1,334	504	830	300	531	20·8	36·1	11·3
Total remainder of region	2,018	147	93·0	21·7	23,382	251	12	2,051	686	1,365	487	878	21·1	35·7	9·4
Total Eastern	3,096	224	185·3	16·7	53,505	289	17	4,639	1,665	2,974	1,065	1,909	20·8	35·8	10·3
London and South-Eastern															
County of London	3,348	215	285·4	11·7	114,180	400	34	11,466	4,491	6,975	2,107	4,869	24·1	30·2	17·1
Croydon	250	15	18·8	13·3	5,748	306	23	490	191	299	104	195	20·5	34·8	10·4
Harrow	219	10	12·4	17·7	4,380	353	20	392	151	241	89	152	21·5	36·9	12·3
Ealing	187	9	13·1	14·3	4,447	339	24	390	149	241	85	156	21·0	35·3	11·9
Ilford	185	6	10·5	17·6	3,811	363	21	331	126	205	77	128	20·8	37·6	12·2
Willesden	180	12	16·3	11·0	5,588	343	31	488	181	307	108	199	21·0	35·2	12·2
West Ham	171	7	11·0	15·5	4,535	412	27	351	127	224	76	148	18·6	33·9	13·5
Brighton	156	14	16·8	9·3	6,335	377	41	612	239	374	130	244	23·2	34·8	14·5
Hendon	156	14	21·9	7·1	6,442	294	41	570	221	349	126	223	21·2	36·1	10·2
Wembley	131	5	7·3	17·9	2,608	357	20	234	90	143	55	88	21·5	38·5	12·1
Tottenham	127	7	7·2	17·6	3,202	445	25	262	98	164	60	104	19·6	36·6	14·4
Walthamstow	121	5	7·3	16·6	2,459	337	20	201	75	126	40	86	19·6	31·7	11·8
East Ham	121	5	9·2	13·2	3,390	368	28	284	102	182	46	137	20·1	25·3	14·9
Enfield	110	4	5·1	21·6	1,894	371	17	171	66	105	37	68	21·7	35·2	13·3
Heston	107	6	9·3	11·5	2,891	311	27	254	98	156	57	99	21·1	36·5	10·6
Leyton	105	9	11·9	8·8	4,200	353	40	347	130	217	77	140	19·8	35·5	11·8

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 6—*continued.*

	Population ('000)	Cinemas (Number)	Seats ('000)	Population per Seat (Number)	Admissions ('000)	Admissions per Seat (Number)	Admissions per Person (Number)	Gross Takings (£'000)	Tax (£'000)	Net Takings (£'000)	Film Hire (£'000)	Exhibitors' Share (£'000)	Average Price of Admission (Pence)	Film Hire as Proportion of Net Takings (Per cent.)	Exhibitors' Share per Seat (£)
Other towns over 100,000	324	13	23·1	14·0	8,406	364	26	724	276	449	152	297	20·7	33·9	12·9
Total towns over 100,000	5,998	356	486·6	12·3	184,516	379	31	17,568	6,809	10,759	3,425	7,333	22·9	31·8	15·1
Total towns 50–100,000	2,205	110	138·9	15·9	45,407	327	21	4,002	1,529	2,473	897	1,576	21·2	36·3	11·3
Total remainder of region	2,699	198	176·3	15·3	49,990	284	19	4,432	1,659	2,774	990	1,785	21·3	35·7	10·1
Total London and South-Eastern	10,902	664	801·8	13·6	279,913	349	26	26,002	9,997	16,006	5,312	10,694	22·3	33·2	13·3
Southern															
Portsmouth	233	20	25·0	9·3	8,018	321	34·	674	255	419	157	262	20·2	37·5	10·5
Southampton	178	15	17·7	10·1	6,017	340	34	531	208	323	117	206	21·2	36·2	11·6
Bournemouth	145	14	16·5	8·8	5,206	316	36	549	218	331	125	206	25·3	37·8	12·5
Total towns over 100,000(*a*)	557	49	59·2	9·4	19,241	325	35	1,755	681	1,074	400	674	21·9	37·2	11·4
Total towns 50–100,000(*a*)	390	25	29·2	13·4	9,781	335	25	948	374	574	209	364	23·3	36·4	12·5
Total remainder of region	1,701	127	84·7	20·1	25,013	295	15	2,260	835	1,425	502	924	21·7	35·2	10·9
Total Southern	2,648	201	173·1	15·3	54,035	312	20	4,963	1,890	3,073	1,111	1,962	22·0	36·2	11·3
South-Western															
Bristol	442	30	30·1	14·7	10,426	346	24	921	353	568	208	361	21·2	36·6	12·0
Plymouth	209	7	11·5	18·2	5,344	465	26	457	175	282	101	181	20·5	35·8	15·7
Total towns over 100,000	651	37	41·6	15·6	15,770	379	24	1,378	528	850	308	542	21·0	36·2	13·0
Total towns 50–100,000	407	29	31·4	13·0	11,707	373	29	1,079	418	661	248	411	22·1	37·5	13·1
Total remainder of region	1,963	190	104·9	18·7	28,969	276	15	2,590	912	1,678	615	1,065	21·5	36·7	10·2
Total South-Western	3,021	256	177·9	17·0	56,446	317	19	5,047	1,858	3,189	1,171	2,018	21·5	36·7	11·3
Wales															
Cardiff	244	18	24·8	9·8	8,312	335	34	736	285	451	173	278	21·3	38·4	11·2
Swansea	161	12	15·5	10·4	4,709	304	29	412	162	250	97	153	21·0	38·8	9·9
Rhondda	111	19	12·1	9·2	4,297	355	39	223	47	176	68	108	12·5	38·6	8·9
Newport	105	8	8·7	12·1	3,849	442	37	350	135	215	73	143	21·8	34·0	16·4
Total towns over 100,000	621	57	61·1	10·2	21,167	346	34	1,721	629	1,092	411	681	19·5	37·6	11·1
Total towns 50–100,000	61	9	6·8	9·0	2,180	321	36	137	43	94	40	54	15·1	42·6	7·9
Total remainder of region	1,915	286	188·4	10·2	48,790	259	25	3,392	1,058	2,335	874	1,460	16·7	37·4	7·7
Total Wales	2,597	352	256·3	10·1	72,137	281	28	5,250	1,730	3,521	1,325	2,195	17·5	37·6	8·6
Southern regions															
Total towns over 100,000(*a*)	11,180	771	963·2	11·6	350,784	364	31	30,800	11,678	19,122	6,395	12,727	21·1	33·4	13·2
Total towns 50–100,000(*a*)	4,472	301	339·8	13·2	114,450	337	26	9,840	3,726	6,114	2,214	3,898	20·6	36·2	11·5
Total remainder of area	14,412	1,325	913·0	15·8	250,387	274	17	20,327	7,096	13,234	4,724	8,512	19·5	35·7	9·3
Total Southern regions	30,064	2,397	2,215·9	13·6	715,621	323	24	60,967	22,499	38,470	13,333	25,137	20·4	34·7	11·3
Great Britain															
Total towns over 100,000(*a*)	18,614	1,573	1,870·1	10·0	682,017	365	37	52,983	19,175	33,808	11,574	22,233	18·6	34·2	11·9
Total towns 50–100,000(*a*)	6,539	534	590·4	11·1	202,525	343	31	16,073	5,912	10,161	3,702	6,457	19·0	36·4	10·9
Total remainder of country	23,689	2,490	1,760·3	13·5	498,838	283	21	35,702	11,964	23,743	8,579	15,167	17·2	36·1	8·6
Total Great Britain	48,841	4,597	4,220·7	11·6	1,383,380	328	28	104,759	37,052	67,711	23,855	43,857	18·2	35·2	10·4

(*a*) Owing to disclosure, Reading (population 114,000, 9 cinemas) is included with towns of 50–100,000 population.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

more or less continuous urban area. The table shows clearly that the number of seats in relation to the population is by no means constant throughout the country. The number of seats in relation to the population is greatest in Scotland where there is one seat for every 8·6 persons, and it is high in each of the three northern regions of England (Northern, East and West Ridings and North-Western). In these regions and Scotland taken together there is one seat for every 9·4 persons while in the remaining seven regions there is only one for every 13·6. We have found, indeed, that the structure of the industry, and also the pattern of cinema-going, is in many respects different in the north, and we shall in later parts of the paper again compare these four regions with the rest of the country. The distinction between the two parts of the country is less clear in the case of the average size of cinemas, although in the three northern areas of England it is well below the average for all cinemas. In Scotland, however, the figure is well above the average, though it has hardly changed between 1934 and 1951. It is, however, the London and South-Eastern region, with 1,208 seats which has the highest average size. In no other region is the average as high as 1,000. In the Eastern and South-Western regions, areas with a relatively low degree of urbanization, the average size is particularly low. The extent to which the average size tends to be smaller in rural and the smaller urban areas is shown in the table. In areas with a population of 50,000 or more, the average is 1,168 compared with 707 in areas with less than 50,000 population. The contrast is greatest in Scotland where the average size in towns with more than 50,000 inhabitants is 1,370, almost as high as in the London and South-Eastern region, but only 777 in the remainder of the country. There is also a greater availability of seats in relation to the population in the urban areas, which have one seat for every 10·2 persons compared with one to every 13·5 in the other areas. The worst served area from this point of view is the more thinly populated part of the Eastern region where there is only one seat for every 21·7 persons. Only in the Northern region is there greater availability of seats in the less populated areas.

Rowson was able to give very little information about circuits beyond quoting, from company reports, the growth in the number of cinemas held by some of the more important circuits of that time. With more complete data, we are now able to make analyses showing the importance of the circuits and types of cinemas held by them. Cinemas have been classified according to

TABLE 7

Circuit Holdings of Cinemas and Seats, March 31st, 1951. Analysis by Size of Cinema.

	Size of Cinemas (Number of Seats)									
	Up to 250	251–500	501–750	751–1,000	1,001–1,250	1,251–1,500	1,501–1,750	1,751–2,000	*Over* 2,000	*Total*
Singleton cinemas										
Cinemas (1)	104	508	434	283	127	49	31	12	8	1,556
(2)	6·7	32·6	27·9	18·2	8·2	3·1	2·0	0·8	0·5	100·0
Seats (1)	22·6	197·4	271·2	247·0	141·8	65·4	49·5	20·7	19·9	1,035·6
(2)	2·2	19·1	26·2	23·9	13·7	6·3	4·8	2·0	1·9	100·0
Small circuits										
Cinemas (1)	50	261	365	266	143	79	27	25	14	1,230
(2)	4·1	21·2	29·7	21·6	11·6	6·4	2·2	2·0	1·1	100·0
Seats (1)	10·2	102·2	226·1	231·5	159·5	106·9	43·5	43·9	32·8	956·7
(2)	1·1	10·7	23·6	24·2	16·7	11·2	4·5	4·6	3·4	100·0
Medium circuits										
Cinemas (1)	9	91	150	163	123	50	28	23	26	663
(2)	1·4	13·7	22·6	24·6	18·6	7·5	4·2	3·5	3·9	100·0
Seats (1)	2·0	36·8	94·6	142·8	134·9	67·5	45·3	41·7	68·1	633·8
(2)	0·3	5·8	14·9	22·5	21·3	10·7	7·1	6·6	10·7	100·0
Large circuits										
Cinemas (1)	2	37	94	183	196	156	178	146	156	1,148
(2)	0·2	3·2	8·2	15·9	17·1	13·6	15·5	12·7	13·6	100·0
Seats (1)	0·4	16·0	61·3	162·8	219·4	214·9	286·8	271·1	361·8	1,594·6
(2)	—	1·0	3·8	10·2	13·8	13·5	18·0	17·0	22·7	100·0
Total Cinemas	165	897	1,043	895	589	334	264	206	204	4,597
Seats	35·2	352·5	653·2	784·2	655·5	454·8	425·3	377·5	482·5	4,220·7

(1) Number of cinemas or '000 seats.
(2) Percentage of cinemas or seats held by singleton cinemas or circuits.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 8

Circuit Holdings of Cinemas and Seats, March 31st, 1951. Analysis by Region

		Administrative Region													
		Scotland	*Northern*	*East and West Ridings*	*North-Western*	*Total Northern Regions*	*North Midland*	*Midland*	*Eastern*	*London and South-Eastern*	*Southern*	*South-Western*	*Wales*	*Total Southern Regions*	*Total Great Britain*
Singleton cinemas															
Cinemas	(1)	209	150	194	231	784	100	117	64	136	52	108	195	772	1,556
	(2)	34·7	35·5	42·3	32·3	35·6	30·1	31·8	28·6	20·5	25·9	42·2	55·4	32·2	33·8
Seats	(1)	149·3	91·1	145·4	167·1	553·0	64·0	81·0	37·0	106·5	27·3	50·0	116·9	482·6	1,035·6
	(2)	25·2	27·7	35·9	24·6	27·6	23·2	23·5	20·0	13·3	15·8	28·1	45·6	21·8	24·5
Small Circuits															
Cinemas	(1)	149	143	137	225	654	107	108	67	104	61	69	60	576	1,230
	(2)	24·7	33·8	29·8	31·5	29·7	32·2	29·3	29·9	15·7	30·3	27·0	17·0	24·0	26·8
Seats	(1)	133·6	109·2	110·2	204·9	558·0	73·8	88·4	46·0	70·5	41·3	36·1	42·7	398·7	956·7
	(2)	22·6	33·2	27·2	30·2	27·8	26·7	25·6	24·8	8·8	23·9	20·3	16·7	18·0	22·7
Medium Circuits															
Cinemas	(1)	109	55	67	97	328	73	35	34	81	13	23	76	335	663
	(2)	18·1	13·0	14·6	13·6	14·9	22·0	9·5	15·2	12·2	6·5	9·0	21·6	14·0	14·4
Seats	(1)	134·3	37·0	59·8	87·8	318·9	65·3	36·0	22·3	92·9	11·5	20·2	66·7	314·9	633·8
	(2)	22·7	11·2	14·8	12·9	15·9	23·6	10·4	12·0	11·6	6·6	11·4	26·0	14·2	15·0
Large Circuits															
Cinemas	(1)	136	75	61	162	434	52	108	59	343	75	56	21	714	1,148
	(2)	22·6	17·7	13·3	22·7	19·7	15·7	29·3	26·3	51·7	37·3	21·9	6·0	29·8	25·0
Seats	(1)	174·2	91·7	89·6	219·3	574·8	73·4	140·0	80·2	531·8	93·0	71·5	29·9	1,019·8	1,594·6
	(2)	29·5	27·9	22·1	32·3	28·7	26·6	40·5	43·3	66·3	53·7	40·2	11·7	46·0	37·8
Total															
Cinemas	(1)	603	423	459	715	2,200	332	368	224	664	201	256	352	2,397	4,597
	(2)	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Seats	(1)	591·4	329·1	405·1	679·2	2,004·8	276·3	345·3	185·3	801·8	173·1	177·9	256·3	2,215·9	4,220·7
	(2)	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

(1) Numbers of cinemas or '000 seats. (2) Percentage of cinemas or seats in each region.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

whether they are controlled by circuits containing 2 to 10 cinemas (small circuits), 11–50 cinemas (medium), over 50 cinemas (large circuits) or are not in circuits at all (singleton cinemas).

Table 7 gives the distribution of this classification by size of cinemas and shows clearly that the larger cinemas are predominantly owned by the large circuits and that there is a direct relationship between the size of cinemas and the size of the circuits to which they belong. Thus two-thirds of the seating capacity in cinemas with up to 250 seats is outside the circuits, while only 4 per cent. of those in cinemas with over 2,000 seats is outside. At the other extreme the largest circuits control only 2 cinemas with fewer than 250 seats but three-quarters of the seats in cinemas with over 2,000 seats. Of all the seats in cinemas outside the circuits, nearly three-quarters are in cinemas with less than 1,000 seats, while over four-fifths of the seats in cinemas in the largest circuits are in cinemas with over 1,000 seats. The average size of cinemas controlled by the largest circuits was 1,389 seats, more than double that of cinenas outside circuits. Table 8 shows that the large circuits are most powerful in the south and particularly in London. In the London and South-Eastern region the largest circuits control over half the cinemas, containing two-thirds of the seats while singleton cinemas contain only about one-eighth of the seats. In the Eastern, Southern, South-Western and Midland regions also, the largest circuits control over 40 per cent. of the seats. The large circuits are weakest, and the singleton cinemas strongest, in Wales where over half the cinemas (containing slightly less than half the seats) are outside circuits and the largest circuits control only just over a tenth of the number of seats. The small circuits are most important in the Northern and North-Western regions. In both of these regions about a third of the cinemas and seats are in circuits with 2 to 10 cinemas.

Changes of Programme

The availability of a varied cinema entertainment depends not only on the number of cinemas and seats in relation to the population but also upon the frequency with which the programmes are changed. The regional pattern of the number of times each week programmes are changed is shown in Table 9.

TABLE 9

Changes of Programme(a). *Second Quarter of* 1950.

	Cinemas Showing One Programme a Week		*Cinemas Showing Two Programmes a Week*		*Cinemas Showing Three Programmes a Week*	
	Number	*Per cent.*	*Number*	*Per cent.*	*Number*	*Per cent.*
Scotland	65	10·8	306	51·0	229	38·2
Northern	55	13.0	235	55·7	132	31·3
East and West Ridings	67	14·5	301	65·3	93	20·2
North-Western	157	21·9	471	65·8	88	12·3
North Midland	54	16·5	214	65·4	59	18·0
Midland	77	21·2	265	73·0	21	5·8
Eastern	59	26·6	160	72·1	3	1·4
London and South-Eastern(*b*)	366	57·4	263	41·2	9	1·4
Southern	44	21·4	161	78·2	1	0·5
South-Western	50	19·6	194	76·1	11	4·3
Wales	57	16·2	254	72·2	41	11·6
Great Britain(*b*)	1,051	23·0	2,824	61·9	687	15·1

(*a*) Exludes changes for different Sunday programme and for special children's performances.
(*b*) Excludes 18 cinemas in the London and South-Eastern region which operated as "long run" cinemas.

In the north the variety of programmes available each week is appreciably greater than in the south. Broadly, in these regions the striking contrast with the south is in the relatively high proportion of cinemas showing three programmes a week. In most regions in the south the number of cinemas showing three programmes a week is negligible and the proportions showing

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

two programmes a week or making no change are higher; in Scotland and the Northern region about a third of the cinemas make two changes. In the London and South-Eastern region the pattern is exceptional; well over half the cinemas change their programme only once a week, more than twice the proportion in any other region.

No information is readily available to us as to the size of cinemas in each of these categories, but it is probable that it is in general the smaller cinemas that make the most frequent changes of programme. Even so, it is clear that the greater partiality of northern folk for cinema entertainment is met to some extent by more frequent changes in programme.

Type of Programme

About three-quarters of the cinemas in the country normally present a double feature programme, but here again we find that there are significant differences in different areas which are shown in Table 10.

TABLE 10

Type of Programme(a). *First Quarter of* 1950

	Cinemas Showing Single Feature Programmes			*Cinemas Showing Double Feature Programmes*		
	Cinemas	*Percentage*	*Average Size (seats)*	*Cinemas*	*Percentage*	*Average Size (seats)*
Scotland	150	25·0	595	449	75·0	1,112
Northern	209	50·7	664	203	49·3	914
East and West Ridings	214	46·7	786	244	53·3	971
North-Western	340	47·8	902	372	52·2	1,005
North Midland	80	24·3	738	249	75·7	874
Midland	27	7·5	644	335	92·5	970
Eastern	14	6·4	479	206	93·6	850
London and South-Eastern	37	5·8	927	605	94·2	1,251
Southern	19	9·3	495	186	90·7	884
South-Western	21	8·3	229	233	91·7	736
Wales	62	17·8	568	286	82·2	777
Great Britain	1,173	25·8	741	3,368	74·2	988

(*a*) The figures exclude 42 news theatres.

In the three northern regions of England only about half the cinemas show double feature programmes although the practice in Scotland is the same as the average for the country as a whole. The practice in the North Midland region is similar to that in Scotland, but in the remaining six regions in the South of England the double feature programme is firmly entrenched and less than a tenth of the cinemas show single feature programmes.

The main regions where the double feature habit is most prevalent are those where the larger circuits are strongest and regional variations are largely to be explained by differences in the structure of the industry. To some extent, however, they are due to local habits or preferences which cut across other factors. In all regions the average size of cinemas showing double features is much above the average of the single feature cinemas but while in the South only a few of the very smallest cinemas show single feature programmes, in the Northern regions the average size of single feature cinemas is much closer to the average of all cinemas. In Wales, on the other hand, where singleton cinemas prevail to the greatest extent, the double feature habit conforms more to the pattern of the south of the country than to that of the north.

Number of Performances and Length of Programme

The exhibitors' enquiry for the fourth quarter of 1950 obtained information about the number of hours cinemas opened in the week December 3rd–9th and the number of times the first feature film was shown.* The latter can be taken, without much inaccuracy, as being equivalent to the

* *Board of Trade Journal*, May 26th, 1951.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

number of performances and on this basis the number of performances during the week ranged from 12 in Wales to 20 in the London and South-Eastern region, but taking the four northern regions together the average number of performances was 14 compared with 16 in the seven southern regions. There was, however, a more direct relationship between the size of cinemas and the number of performances, the number ranging from an average of 7 in the smallest group (less than 250 seats) to 20 in cinemas with over 1,750 seats. The average length of programmes was slightly shorter in the north, being not much more than 2½ hours in each of the four northern regions but over 2¾ hours in the southern regions. In the London and South-Eastern region the average length was nearly 3 hours. There was little relationship between size of cinemas and length of programmes.

The general picture is, therefore, one of fewer and shorter performances in the north compared with the south.

III. The Cinema-going Habit

The Cinema Audience

We saw earlier that the number of cinema admissions in 1952 was 1,312 million, representing nearly 27 visits for every man, woman and child in the country. It may be assumed that attendances by children under five years of age are negligible, so that the average number of attendances by persons of five and over was 29 in 1952. This figure, however, conceals some important variations. In the *Hulton Readership Survey* which is based on information obtained from a sample survey of the adult population, the habits of the cinema-going public are analysed each year. On the basis of the figures from this survey for 1952 we have made estimates of the number of attendances by persons of different age-groups, the number of visits by children under 16 being obtained by deduction. This figure we think may be too low, although it can just be reconciled with the results given in a report on *Children and the Cinema* prepared by the Social Survey in 1949* if it is assumed that children's admissions have declined since then rather more than have those of adults.

TABLE 11

Estimated Cinema Attendances in 1952. *Analysis by Age-groups*

Age-groups	*Total Attendances (million)*	*Attendances per Head*
5–15 years	260	34
16–24 ,,	350	62
25–34 ,,	270	38
35–44 ,,	170	23
45–64 ,,	220	18
Over 64 ,,	40	7
Total	1,310	29

Based on Hulton Readership Survey.

Although these figures are only approximate they show that nearly half of all cinema attendances are made by persons below the age of 25 and no less than one-fifth by children under the age of 16. Young people between the ages of 15 and 25 go to the cinema on the average nearly twice as frequently as people in any other age-group. The number of attendances by males and females do not appear to be significantly different, but since there are more women than men it follows that men go to the cinema rather more frequently than women. This is contrary to the findings of the Social Survey in 1946, reported in *The Cinema and the Public*, that the average number of attendances per month was 2·39 for women and 2·04 for men. However, the *Hulton Survey* has reported a decline in women's attendances from 0·60 a week in 1948 to 0·47 in 1952, and in those for men from 0·59 to 0·52, the trends being continued in 1953. Although these figures

* From *Children in the Cinema* it is deduced that children aged 5–9 went to the cinema on the average about 3 times a month in 1949 and those aged 10–15 went about 4½ times. These rates imply a total of about 120 million visits in the year by the former group and about 200 million by the latter.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

exaggerate the movement that has taken place it seems clear that the post-war decline in admissions has been much more pronounced among women than among men; and, as already noted, it may have been more among children than among adults.

Looking at the breakdown of admissions by income-groups, all surveys agree that the attendance rate is highest for the lower middle class and lowest for the relatively well-off. The *Hulton Survey* shows that nearly four-fifths of all attendances in 1952 were by members of households where the head of the household had an income of less than about £600 a year, and that people of this class went to the cinema half as often again as those who were better off.

Of the average cinema audience, the *Hulton Survey* finds that about five-sixths of those present attend the cinema once a week or more often. In *The Cinema and the Public* it was reported that in 1946 nearly three-quarters of those who went to the cinema once a month or more went regularly, whatever films were being shown, and, of these, only two-thirds exercised any choice among films being shown at different cinemas, the remainder always attending the same cinema.

Most cinema-goers therefore are pretty indiscriminating in their choice of films. Indeed, reflection on the composition of the average audience suggests some explanation of why it is that box-office successes are not invariably films that find favour with the critics.

Variations in Attendances

There are considerable variations in the cinema-going habit in different parts of the country. Table 6 shows that the number of visits per head of the population in the year April, 1950, to March, 1951, varied from 37 in the Northern region and 36 in Scotland to 17 in the Eastern region. In the four northern regions the average was 36; for the seven southern ones it was only 24. In towns the rate of attendance is invariably higher than in other districts.

The share of total admissions achieved by singleton cinemas and by circuits of different sizes is shown in the first four columns of Table 12.

TABLE 12

Proportion of Admissions in Singleton and Circuit Cinemas. Analysis by Region

	All Admissions(a)				*Sunday Admissions*(b)				*Special Children's Admissions*(c)			*Per cent.*
		Circuits				*Circuits*				*Circuits*		
Region	*Singleton*	*Small*	*Medium*	*Large*	*Singleton*	*Small*	*Medium*	*Large*	*Singleton*	*Small*	*Medium*	*Large*
Scotland	22	22	24	32	27	25	20	28	12	3	7	78
Northern	27	32	8	33	25	28	13	34	22	20	17	41
East and West Ridings	31	26	18	25	21	27	15	37	27	18	9	47
North Western	22	30	12	36	17	30	12	41	21	22	16	41
4 Northern Regions	25	27	16	32	20	29	13	38	21	18	13	48
North Midland	20	25	24	31	16	20	24	40	13	22	16	49
Midland	20	25	10	45	16	25	10	49	16	19	12	53
Eastern	18	22	9	51	17	20	13	50	7	11	6	77
London and South-Eastern	11	9	14	66	13	10	13	64	2	3	1	93
Southern	13	23	5	59	11	22	6	61	3	17	4	76
South Western	21	19	10	50	15	20	7	58	7	14	1	78
Wales	39	18	27	16	28	20	19	33	23	18	34	25
7 Southern Regions	18	17	15	50	15	17	12	56	8	12	8	72
Great Britain	21	22	16	41	17	21	12	50	13	14	10	62

(a) January–March, 1951.
(b) October–December, 1951.
(c) April–June, 1952.

The pattern here is very similar to that shown in the analysis of seats in Table 8, except that the position of the large circuits is generally stronger, due to the fact that the number of admissions per seat in their cinemas is higher. In the seven southern regions half of the total admissions are to cinemas in large circuits and less than a fifth to singleton cinemas; in the four northern regions the proportions are a third and a quarter respectively.

Sunday Performances

Information about Sunday film exhibitions was collected in the second quarter of 1950 and the fourth quarter of 1951. The general decline in admissions between these periods was reinforced by seasonal tendencies, so that total admissions in the later period were less than in the earlier

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

one. Yet Sunday admissions increased from 30·6 million in the spring of 1950 to 32·4 million in the autumn of 1951, an increase of 5·5 per cent. compared with a decrease of 6·1 per cent. in week-day admissions. There were, however, 78 more cinemas (3 per cent.) open on Sundays in 1951 compared with 1950. Fifty-eight of these new Sunday cinemas were in the four northern regions, although Sunday admissions increased by only 3·6 per cent. between the two periods compared with 6·7 per cent. in the seven southern regions. In the north Sunday admissions in the fourth quarter of 1951 were 7·6 per cent. of total admissions (10·1 per cent. if Scotland is excluded), but in the south the proportion was 12·2 per cent. Nevertheless, admissions on Sunday in the three northern regions of England were more per head of the population than in the six southern regions. The experience in Scotland and Wales is in marked contrast to England. In Scotland only about one in twelve cinemas were open on Sunday in 1951 (compared with two out of three in the country as a whole) and under 1 per cent. of all admissions were on Sunday; in Wales the corresponding proportions were one in ten and 2 per cent. This is perhaps some indication of the strength of nonconformist traditions in these countries.

Table 12 shows that except in Scotland, the Eastern region and London the large circuits accounted for a higher proportion of Sunday admissions than for all admissions. In areas where large circuits are strongest their share of Sunday business did not differ much from what was obtained on week-days because the great majority of cinemas are open on Sunday (97 per cent. in London and the South-East, 88 per cent. in the Southern and 76 per cent. in the Eastern regions). Where Sunday opening is not such a normal practice it is generally the large circuits which are setting the example, Scotland being the important exception. Similarly it may be noted that, except in Scotland and London and the South-East, singleton cinemas attract proportionately less of the business on Sundays than on other days.

Special Children's Performances

In the third quarter of 1950 and the second quarter of 1952 questions were asked about admissions and takings at special film performances given for children. These performances are given either for children's clubs, attended by club members, or at children's matinées, open to all children. In *Children in the Cinema* it was reported that the former were mainly in the south of England, and the latter in the north, and that children attending these performances tended to go to the cinemas more frequently than others. In 1950 it was found that attendances at these special performances (12,396,000 in the quarter) accounted for 3·5 per cent. of all cinema attendances; in 1952 the figure (13,372,000) was 4·1 per cent. The absolute figures may be compared with the findings of *Children in the Cinema* that such attendances totalled about 900,000 a week (11,700,000 a quarter) in November, 1948; at that time the proportion of total attendances accounted for by children's performances was unlikely to have much exceeded 3 per cent. While total admissions to cinemas declined from 1,514 million in 1948 to 1,312 million in 1952, a fall of 13 per cent., admissions to children's performances rose by about 14 per cent. In 1948 special performances probably accounted for not more than about one-seventh of all children's admissions, in 1952 they were probably about one-fifth. To some extent therefore it seems likely that the development of these performances has been at the expense of children's attendances at ordinary performances, but it is almost certain that there has been some net advantage to the cinema managers in terms of attendances, the decrease in the total being less than it would otherwise have been.

We have found comparatively little variation in the number of visits to children's performances per head of the child population in the regions, except in Scotland where the rate was less than half the average. In the north of England the rate of attendance was rather higher in the second quarter of 1952 than in the south, but for the four northern regions together (including Scotland) the rate was about the same as in the seven southern ones. As can be seen from the last set of columns in Table 12 the large circuits accounted for a higher proportion of these admissions than any other group in every region except Wales. Where large circuits are particularly strong, in the Eastern, London and South-Eastern, Southern and South-Western regions, they accounted for more than three-quarters of admissions to special children's performances; this was also true of Scotland. These results are striking evidence of the lead given by the large circuits in this specialized field.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Cinema Capacity

We have discussed the various factors such as the number of seats, changes of programme and numbers of performances, which, in relation to the population, affect the availability of cinema entertainment in different parts of the country, and also the regional variations in the amount of cinema-going. It is convenient to bring these two aspects together by looking at the proportion of cinema capacity that is normally filled; the capacity of a cinema in a given period being the product of the number of its seats and the number of performances given. Thus a 2,000 seat cinema giving 20 performances in a week has a weekly capacity of 40,000. The number of times first feature films were shown during the week December 3rd–9th, 1950, may be equated, with a fair degree of accuracy, to the number of performances given, but this ignores the fact that in some cases the daily programme begins and ends with the first feature film. By using this information it is possible to estimate the amount of cinema capacity available during the week. The information about the number of times the first feature was shown in the week was analysed for each size group in each region and the average for each cell was multiplied by the number of seats available (obtained from the quarterly enquiry for the following period when the number of seats in each cinema was stated) to obtain the estimate of the number of seat/performances during the week. The number of seats in news theatres, which do not show feature films and were therefore automatically excluded from the analysis of first feature showings, was excluded from this calculation. The first columns of Tables 13 and 14 give the estimates analysed by region and by size of cinemas, and the second columns in these tables show the weekly average number of admissions during the fourth quarter of 1950. These figures exclude admissions to news theatres and also an estimate of those to special performances for children at which first features are not shown. Admissions to children's performances were not collected separately for the fourth quarter of 1950 and they have been taken to represent the same proportions of the totals as in the previous quarter, the enquiry for which included questions about these performances. The total number of admissions to these performances represent less than 4 per cent. of all admissions and the inaccuracies involved in this assumption must be negligible. The third columns in the tables relate admissions to capacity, showing the proportions of capacity filled.

The results derived from this analysis are subject, of course, to the qualification that they related to one particular quarter—a quarter in which the number of admissions is seasonally low—but this is not serious enough to detract greatly from the broad conclusions that can be drawn from them.

During the period 33·3 per cent. of available capacity was occupied, but in each of the three northern regions and Scotland the proportion was above the average for the country, while in each of the southern regions, with the exception of Wales, it was below the average. Taken together, cinemas in the north were 5 per cent. fuller than those in the south. Relating, therefore, the various factors we have discussed, we find that in the north the picture is one of a relatively high level of cinema-going catered for by a large number of seats in relation to the population and frequent changes of programme, but with fewer performances, with the result that cinemas operate with a higher proportion of their capacity filled than in the south where the reverse is true in the case of each of these factors.

In Table 13 we have further analysed admissions and capacity into the parts relating to Sunday and weekday performances respectively. Capacity on Sunday was calculated in a similar manner to capacity during the whole of the week, but as information about attendances on Sundays was not collected for the fourth quarter of 1950 it was necessary to assume that the proportion of admissions on Sunday to total admissions during that period was the same as during the second quarter, for which the information was obtained. Some error will, of course, be involved in this assumption, but there is no reason to believe that it would be anything like sufficient to invalidate the results of the analysis. Cinemas which open on Sundays normally do so for a shorter period than on weekdays and fewer performances are given and the results of the analysis show that although, for the country as a whole, there was less than half the capacity on Sunday compared with an average weekday, attendances were nearly two-thirds of those on weekdays and that consequently cinemas were about 10 per cent. fuller on Sundays. This was the case in all regions apart from Scotland, where, although only a small fraction of capacity was available on Sundays the propensity to cinema-going was also very small and less than 30 per cent. of capacity was

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

filled compared with 43 per cent. for the country as a whole, and over 56 per cent. in the nearest English region.

TABLE 13

Cinema Capacity Available and Filled (a) *during the Fourth Quarter of* 1950. *Analysis by Region*

	All Performances			*Weekday Performances*			*Sunday Performances*		
Region	*Capacity Available*(b) ('000)	*Admissions* ('000)	*Proportion of Capacity Filled* (*Per cent.*)	*Capacity Available*(b) ('000)	*Admissions* ('000)	*Proportion of Capacity Filled* (*Per cent.*)	*Capacity Available*(b) ('000)	*Admissions* ('000)	*Proportion of Capacity Filled* (*Per cent.*)
Scotland	9,376	3,297	35·2	9,294	3,273	35·2	82	24	29·3
Northern	4,883	2,002	41·0	4,574	1,827	39·9	309	175	56·6
East and West Ridings	6,306	2,362	37·5	5,895	2,165	36·7	411	197	47·9
North Western	11,198	3,794	33·9	10,363	3,387	32·7	835	407	48·7
4 Northern Regions	31,763	11,455	36·1	30,126	10,652	35·4	1,637	803	49·1
North Midland	4,391	1,443	32·9	4,050	1,285	31·7	341	158	46·3
Midland	6,166	1,968	31·9	5,626	1,718	30·5	540	250	46·3
Eastern	3,250	937	28·8	2,962	821	27·7	288	116	40·3
London and South-Eastern	15,873	4,758	30·0	14,236	4,130	29·0	1,637	628	38·4
Southern	3,268	927	28·4	2,921	795	27·2	347	132	38·0
South Western	3,036	955	31·5	2,804	866	30·9	232	89	38·4
Wales	3,379	1,250	37·0	3,333	1,232	37·0	46	18	39·1
7 Southern Regions	39,363	12,238	31·1	35,932	10,847	30·2	3,431	1,391	40·5
Great Britain	71,126	23,694	33·3	66,058	21,499	32·5	5,068	2,195	43·3

(a) Excluding news theatres and special children's performances.
(b) Seat/performances.

TABLE 14

Cinema Capacity Available and Filled (a) *during the Fourth Quarter of* 1950. *Analysis by size of Cinema*

Size of Cinema (*number of seats*)	*Capacity Available*(b) ('000)	*Admissions* ('000)	*Proportion of Capacity Filled* (*per cent.*)
Up to 250	243	113	46·5
251– 500	4,054	1,569	38·7
501– 750	9,313	3,379	36·3
751–1,000	12,697	4,301	33·9
1,001–1,250	11,373	3,678	32·3
1,251–1,500	8,214	2,617	31·9
1,501–1,750	8,261	2,555	30·9
1,751–2,000	7,395	2,408	32·6
Over 2,000	9,577	3,075	32·1
Total	71,126	23,694	33·3

(a) Excluding news theatres and special children's performances.
(b) Seat/performances.

Table 14 shows that the smaller cinemas, particularly the very small ones, which operate with approaching half their capacity filled, are appreciably fuller than the larger cinemas. This is due largely, no doubt, to the fact that a high proportion of the smaller cinemas are in rural areas where it would be quite uneconomical to attempt to provide continuous entertainment during nearly half the day, as cinemas in urban areas normally do, and cinema-going tends in these areas to be concentrated into one, or occasionally two performances during the evening.

Seasonality

Taking the country as a whole, admissions in the first quarter of each year from 1950 to 1952 have been 5 or 6 per cent. higher than the average for the whole year and the last quarter 5 to 7 per cent. below the average. The second quarter has been closest to the average, and the third

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

a few points higher. Looking at the regions individually, the low fourth quarter is common to all, while the second quarter is almost invariably at or just below the yearly average. The relative importance of the first and third quarters appears to depend mainly on whether or not a particular region attracts many holiday visitors in the summer. The principal seaside resorts together had 21 per cent. more admissions in July to September than the yearly average in each of the three years. The effect of holiday business is particularly noticeable in the Eastern, Southern and South-Western regions, where admissions in the third quarter are usually higher than in the first, while in Scotland and the North-Western region there is little to choose between these two quarters. Apart from this qualification, which may be attributed to the temporary migration of cinema-goers from one district to another, there appears to be no significant difference between the habits of people in town and country at different times of the year.

Influence of Television

A large part of the decline in attendances in recent years has been widely attributed to the increasing accessibility of television. There has so far been little information available upon which to judge the extent of any relationship between these two factors and discussion on the matter has been largely surmise. In the U.S.A. where the incidence of television has been much greater than in this country, it has been estimated* that as far back as 1948 areas with satisfactory television reception showed a decrease in cinema business of 40 per cent., those with unsatisfactory reception a decrease of 22 per cent., while areas without television showed an increase of 3 per cent. The derivation of these figures, however, and the period over which the changes occurred, are not stated.

While, with the information available, we are not able to provide a conclusive answer to the problem in this country, the town classification of cinemas, described above, has enabled us to isolate, for the period since the quarterly returns were started, the experience of towns subject to varying degrees of television influence. Although the experience of individual towns is of interest, a general picture is more useful. Our method, therefore, has been to examine the trend of admissions for a number of towns, selected at random, within the range of good reception of Sutton Coldfield (which opened shortly before the quarterly cinema returns started), a number within the range of Holme Moss (which opened in the middle of our period) and a number from areas in which reception was such that the number of television sets was negligible throughout. Table 15 relates cinema admissions in each quarter of the years 1950 to 1952 and the trend of admissions (derived as a four-quarterly moving average) to the number of television licences in force at the end of each quarter, per 1,000 of the population. It should be noted that the figures for television licences were obtained from the G.P.O. and relate to postal districts which normally extend beyond the administrative boundaries of the towns included and to which the admission figures relate. Population figures relating to administrative areas have been used to derive columns (3), (6) and (9) of the table and these, therefore, somewhat overestimate the number of sets per 1,000 of the population. It is, however, the trend over the period that we are interested in, rather than the absolute numbers.

These figures (and, more clearly, the charts) show that the decline in admissions was proportionately greatest in the Sutton Coldfield area which had the greatest concentration of television sets. The trend showed a continuous decline between the third quarter of 1950 and the second quarter of 1952, amounting to 7·5 per cent. In the Holme Moss area, where television reception began in October, 1951, and in which the concentration of television sets was, after that date, about half what it was in the Sutton Coldfield area, the trend showed only a very slight decline up to the third quarter of 1951 but thereafter it declined more rapidly—at about the same rate as in the Sutton Coldfield area. Outside the areas of television reception there was a very slight upward trend between the third quarters of 1950 and 1951 and then a fall until the second quarter of 1952 similar to that in the other areas. In both the Sutton Coldfield and the Holme Moss areas admissions during the third and fourth quarters of 1952 were very much below those for the corresponding periods of 1950 and 1951 and indicate that the trend was falling more steeply. In the other area, however, the decline was much less marked.

* *Financial Times*, August 5th, 1953.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 15

Cinema Admissions and Television Licences in Force, 1950–1952

	Sutton Coldfield(a)			*Holme Moss*(b)			*Towns not Served by Television*(c)		
	Cinema Admissions (1)	*Trend of Admissions* (2)	*T.V. Licences per 1,000 Population*(d) (3)	*Cinema Admissions* (4)	*Trend of Admissions* (5)	*T.V. Licences per 1,000 Population*(d) (6)	*Cinema Admissions* (7)	*Trend of Admissions* (8)	*T.V. Licences per 1,000 Population*(d) (9)
	('000)	('000)	*No.*	('000)	('000)	*No.*	('000)	('000)	*No.*
1950 1st Quarter	11,008	—	12	18,290	—	2	12,089	—	—
2nd ,,	9,998	—	18	16,420	—	3	11,218	—	—
3rd ,,	9,933	10,025	24	16,973	16,861	4	11,554	11,380	—
4th ,,	9,406	9,924	37	15,937	16,819	6	10,644	11,451	—
1951 1st Quarter	10,521	9,814	52	17,940	16,740	9	12,120	11,511	—
2nd ,,	9,677	9,726	64	16,431	16,805	13	11,757	11,540	—
3rd ,,	9,369	9,632	69	16,336	16,723	14	11,492	11,516	—
4th ,,	9,268	9,505	81	16,136	16,438	29(e)	10,936	11,369	1
1952 1st Quarter	9,904	9,405	98	17,087	16,314	43	11,641	11,257	2
2nd ,,	9,278	9,271	101	15,958	16,092	47	11,058	11,182	2
3rd ,,	8,974	—	106	15,812	—	53	11,293	—	3
4th ,,	8,589	—	119	14,882	—	63	10,533	—	4

(a) Worcester, Coventry, Nuneaton, Leicester, Derby and Nottingham.
(b) Warrington, Bradford, Bolton, Huddersfield, Sheffield, Crewe, York, Doncaster, Rotherham and Preston.
(c) Norwich, Plymouth, Exeter, Carlisle, Sunderland, Newcastle and Aberdeen.
(d) At end of period.
(e) Transmission commenced in this period.

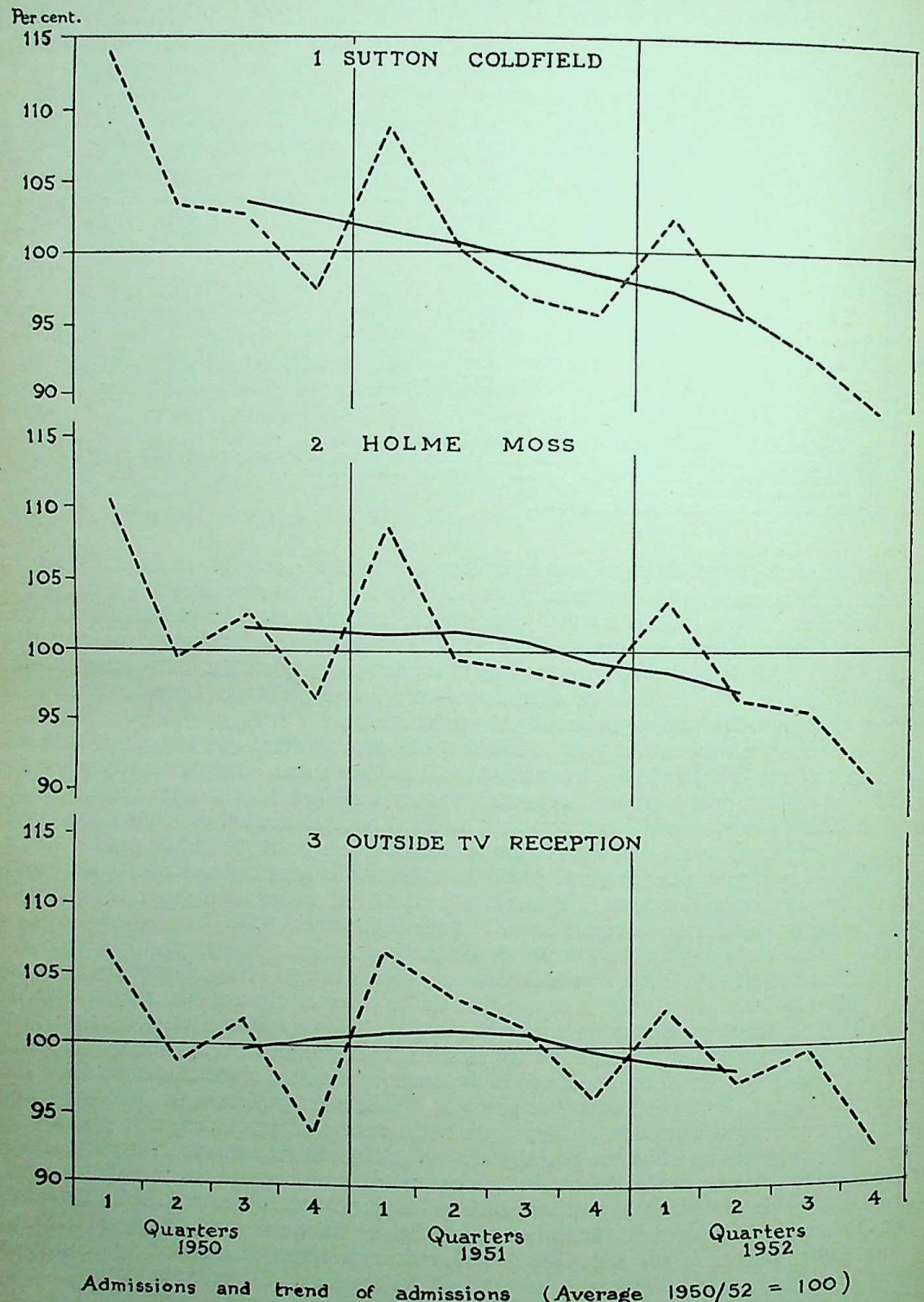
Much the same pattern emerges from an examination of the figures for administrative regions. Measured in the same way and over the same period the decline in cinema admissions in the Midland region was nearly 10 per cent. in the two years, and in London and the South-East, also a region of good television reception, 9 per cent. In the North-Western region, much of which is served by Holme Moss, the decline was 6 per cent. But in regions virtually unaffected by television there was very little change in the level of admissions—in Wales a decline of 1 per cent. and in the Northern and South-Western regions negligible variations.

This analysis presents no clear-cut conclusion, but perhaps three-quarters of the decline in admissions between 1950 and 1952 was due to the effect of television. The influence of economies in family expenditure which we have suggested was responsible for most of the decline between 1946 and 1950 cannot be said, with certainty, to have been eliminated completely, but on the whole it has given way to this new and, from the film industry's point of view, more potent factor. As television coverage is extended, and possibly its hours of transmission increased, it is natural to expect that cinema admissions will continue to decline; but it is as yet too soon to be sure that cinema business will not recover as the novelty of television wears off.

It is of interest to compare this trend with the decline in cinema business that has taken place in the United States. We have seen the extent of the fall there in box-office takings in recent years. This has been reflected in a decrease in the number of conventional theatres which is estimated in the *American Motion Picture and Television Almanac* at about 900 net, or more than five per cent. since 1948, although nearly 3,500 drive-in theatres have opened in the same period. These changes must be considered in the light of the nature of the challenge of television in America. Mass viewing is virtually a post-war development, yet there are already over 300 transmitting stations in operation giving, in the main centres of population, a very wide range of alternative programmes which are available all day. Nearly 90 per cent. of all American families are estimated to be within range of these stations and there are said to be about 27 million receivers, or one for every six persons throughout the country—a proportion not matched in Britain even in the areas of maximum coverage. It seems unlikely that television will reach this level of intensity here for some years, if at all. The threat to cinemas is developing much more gradually, and its effect, though perhaps considerable, may be less far-reaching. So far, at any rate, there has been no great shrinkage in the size of the industry. Only about 30 cinemas, well under 1 per cent. of the total, have dropped out of the Board of Trade survey since the beginning of 1950, and some of these are known to be showing 16 mm. films.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri



Admissions and trend of admissions (Average 1950/52 = 100)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

IV. *Cinema Revenues and Costs*

The first objective for the cinema exhibitor must generally be to maximize his gross margin, that is, the exhibitor's share of revenue after payment of film hire. In doing this he will strike a balance according to his judgement between the quality of the service he offers, the expenditure necessary to maintain that service, and the amount of profit he seeks to earn for himself. In this section an attempt is made to analyse the factors which determine the amount of the exhibitor's share and then to estimate the incidence of maintenance costs so as to arrive at an idea of the viability of the industry and of its various sections in economic conditions which have to come be generally regarded as critical.

Gross Box-Office Takings

The distribution of gross and net takings and exhibitors' share between different types of cinema and different regions is set out in Table 16, the figures relating to the first quarter of 1951.

We may begin by noting, in section A of the table, that the average price of admission increases with the size of the cinema. An exception to this general rule is provided by the smallest cinemas the large majority of which are located in rural areas and are not therefore subject to much direct competition; so enabling them to fix the limited range of prices, which is all that their accommodation allows them to charge, somewhat higher than in the next size groups. (In the week March 11th–17th, 1951, 50 per cent. of the tickets sold in cinemas with 250 seats or less were at more than 1*s.* 3*d.*, compared with 39 per cent. in the next size-group and 36 per cent. in the 501–750 range, the dispersion in the smallest cinemas being less than in the others).

The reasons for the higher price in the larger cinemas are clear. They tend to be more luxurious, frequently offering amenities such as car-parks and restaurants which are beyond the resources of small halls, and are normally " first-run " cinemas, that is, first show newly-released pictures in their locality. For these reasons, and being normally situated in the centres of population, they attract larger audiences, and the ordinary laws of supply and demand operate in determining price. The progression in the number of attendances per seat, shown in col. 3 of Table 16A, is very striking. Since both the rate of admission and the average price are about half as much again in the largest cinemas as in the smallest, their gross takings per seat are about 2¼ times as much. Consequently the industry is dominated by large cinemas to a degree greater than can be accounted for by their numbers or seating capacity. The average size of cinema in 1951, as we have seen, was 918 seats, and only 35 per cent. of all cinemas had over 1,000 seats, accounting for 57 per cent. of the total number of seats, but in the quarter under consideration they accounted for 65 per cent. of the gross takings of the industry. Corresponding figures for the over 1,500's were 15, 30 and 39 per cent.

This dominance of the large cinema largely accounts for the special position in the industry of the large circuits with more than 50 cinemas. The extent of their control of the larger cinemas in the more favourable situations is clearly reflected in their higher rates of admission and higher average prices. Large circuits have only 25 per cent. of all cinemas but 38 per cent. of seats and 48 per cent. of gross takings. (In the seven southern regions their proportion of gross takings is 54 per cent. but in the four northern regions only 39 per cent.) They perform an invaluable service to the industry in setting standards of efficiency, of showmanship and of amenity towards which others must strive as best they can. In return they are able, with their financial resources and their access to the cinema-going public, to exert a strong influence in the distribution of films (some of them are, of course, closely connected with some of the major renting organizations). To a great extent their management policy also influences that of others, and is no doubt an important factor for example in maintaining the double-feature programme as the general rule in cinemas in the south; they have also given a lead in the provision of special children's performances and in many other aspects of cinema policy.

It is therefore perhaps true to say that the important differences between the northern and southern regions of the country, which are shown in section C of Table 16, may be in considerable measure due to the late development and the comparative weakness of circuit influence in the north. It is remarkable that in this part of the country where the cinema-going habit is exceptionally strong by any standard and cinemas are usually fuller than elsewhere, the average price of admission shown in Table 16 should be nearly 5*d.*, or nearly a quarter below the level of the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 16

Cinema Admissions and Distribution of Gross Takings, January to March, 1951

	Seats ('000)	*Admissions* ('000)	*Admissions per Seat* (*Number*)	*Gross Takings* (£'000)	*Tax*(a) (£'000)	*Net Takings* (£'000)	*Film Hire* (£'000)	*Exhibitors' Share* (£'000)	*Average Admission Price* (*d.*)	*Film Hire as Proportion of Net Takings* (*Per cent.*)	*Exhibitors' Share per Seat* (£)
A. *Analysis by size of cinema (Seats)*											
Up to 250	35·2	2,115	60	146	28	118	33	85	16·6	28·0	2·41
251– 500	352·5	26,248	72	1,721	457	1,264	387	877	15·7	30·6	2·49
501– 750	653·2	50,989	78	3,312	1,072	2,242	741	1,500	15·6	33·1	2·30
751–1,000	784·2	64,762	82	4,415	1,495	2,920	1,013	1,908	16·4	34·7	2·43
1,001–1,250	655·5	55,538	85	4,110	1,454	2,656	945	1,711	17·8	35·6	2·61
1,251–1,500	454·8	39,577	87	3,126	1,144	1,982	713	1,269	19·0	36·0	2·79
1,501–1,750	425·3	38,693	91	3,260	1,227	2,033	749	1,284	20·2	36·8	3·02
1,751–2,000	377·5	35,086	93	3,136	1,207	1,929	717	1,212	21·5	37·2	3·21
Over 2,000	482·5	45,607	94	4,392	1,706	2,686	911	1,775	23·1	33·9	3·68
B. *Analysis by size of circuit*											
Singleton cinemas	1,035·6	76,277	74	5,241	1,653	3,587	1,234	2,353	16·5	34·4	2·27
Circuits with 2–10 cinemas	956·7	79,173	83	5,371	1,775	3,596	1,216	2,380	16·3	33·8	2·49
11–50 ,,	633·8	54,744	87	3,878	1,323	2,555	821	1,734	17·0	32·1	2·74
Over 50 ,,	1,594·6	148,421	93	13,127	5,037	8,091	2,937	5,154	21·2	36·3	3·23
C. *Analysis by region*											
Scotland	591·4	48,062	81	3,184	1,039	2,146	764	1,382	15·9	35·6	2·34
Northern	329·1	30,654	93	1,963	629	1,334	482	852	15·4	36·1	2·59
East and West Ridings	405·1	36,557	90	2,449	817	1,633	568	1,064	16·1	34·7	2·63
North Western	679·2	57,937	85	3,919	1,319	2,601	920	1,681	16·2	35·4	2·47
4 Northern regions	2,004·8	173,210	86	11,515	3,803	7,713	2,734	4,979	16·0	35·4	2·48
North Midland	276·3	22,289	81	1,689	597	1,092	371	721	18·2	34·0	2·61
Midland	345·3	30,303	88	2,350	846	1,504	520	984	18·6	34·6	2·85
Eastern	185·3	13,633	74	1,209	438	771	274	497	21·3	35·5	2·68
London and South-Eastern	801·8	72,250	90	6,868	2,669	4,199	1,387	2,812	22·8	33·0	3·51
Southern	173·1	13,817	80	1,298	498	800	286	514	22·5	35·8	2·97
South Western	177·9	14,504	82	1,319	492	827	302	526	21·8	36·5	2·96
Wales	256·3	18,609	73	1,370	447	923	335	588	17·7	36·3	2·29
7 Southern regions	2,215·9	185,405	84	16,103	5,987	10,115	3,475	6,642	20·8	34·4	3·00
Great Britain	4,220·7	358,615	85	27,618	9,789	17,829	6,209	11,621	18·5	34·8	2·75

(*a*) Entertainment Duty and payments to British Film Production Fund.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

remainder. (Although from Table 6, based on a full year's figures, the difference in price is a little under 4*d.*) In spite of some small advantage in the average number of admissions per seat (86 in the first quarter of 1951 against 84 in the south), gross takings in the north account for only 42 per cent. of the total although admissions are 48 per cent. This may be contrasted with the experience of London and the South-East, where admissions are 20 per cent. but takings 25 per cent. of the total. Perhaps the most striking illustration of the importance of what may be described as fashion in the fixing of prices is in the South-West. People attend the cinema in this region less than in almost any other part of the country, there is normally a fairly high proportion of empty seats and the proportion of small cinemas is higher than elsewhere. Yet the average price charged is only one penny less than the very high rate in London and the South-East, and nearly 6*d.* higher than in the very much more favourable market in the north.

The wide differences that have been noted in prices and takings between large and small cinemas, circuits and independents, south and north, are in part determined by the nature of public demand, and in part themselves determine differences in management policy which are reflected in the incidence of costs. These are the subject of the ensuing paragraphs but attention may again be drawn here to the importance of two factors, the prevalence in the north of the single feature programme, and the more frequent change of programme there. There can be little doubt of the efficacy of the first in keeping down the cost of film hire with a consequent effect on admission charges and of the second in maintaining the high admission rate per head of the population by keeping a wide choice of films available.

Entertainment Duty

So far we have considered the average price only. The actual scale of prices adopted by individual cinemas is fixed, however, only approximately according to local conditions. The precise charges have until recently been determined to a great extent by the rate of entertainment duty. In its lower ranges this is a progressive tax, beginning in the current scale with a charge of ½*d.* on the 9*d.* seat (lower prices not being subject to duty) and rising to 10*d.* on the 2*s.* seat (42 per cent.). Thereafter the rate is fairly constant, approximating to a flat percentage of about 42 per cent. Until 1952, however, instead of being charged at 42 per cent. of every penny the tax rose in steps, each step covering a range of admission prices, including duty. These steps varied in size from one penny for the lowest prices to one shilling for the highest, so that at some points in the scale a small increase in price might result in a decrease in the return to the exhibitor. In 1952, however, the scale of duty was revised so that every step in it is now one penny of gross admission price, and part of every increment accrues to the exhibitor. The other features of the duty are not materially changed. This revised structure naturally makes for more flexibility in prices.

Much discussion has been concentrated in the last year or two on the incidence of entertainment duty, largely because this accounts for the largest single charge on gross takings. In the year following Rowson's survey the then Chancellor of the Exchequer was able to make some concessions of which the chief was the exemption for all seats for which the charge was sixpence or less. This served to reduce the overall incidence of duty and in 1938 this was only a little over 13 per cent. of all gross takings. With an average admission price of just over 10*d.* the duty was therefore rather more than 1¼*d.* leaving about 8¾*d.* net for the exhibitor's expenses (including film hire) and profit. With the outbreak of war taxation was everywhere increased, and the rate of entertainment duty was increased in successive stages until 1943. At that point the proportion of duty was 35½ per cent. This increase was largely responsible for the increased price of admission —out of an average price of 17*d.* about 6*d.* was duty, leaving 11*d.* net. Since then the price increases have rather more than kept pace with the comparatively small increase in duty and in 1952 out of the average price of 20*d.* barely 7*d.* was taken in duty, leaving 13*d.* for the exhibitor—an incidence of duty of less than 35 per cent.

The "Eady" Levy

Apart from duty, certain proposals were made in 1950 for helping British film production and agreement was reached amongst the various sections of the trade for the introduction of a special levy to be collected by exhibitors and paid into a fund known as the British Film Production

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Fund. At first the rate was ¼*d.* for each admission subject to the exemption of cinemas with low weekly takings. In 1951 the rate of levy was increased to ¾*d.* on seats costing more than 1*s.*

Exemption of Small Cinemas

There are some important variations in the incidence of tax and levy among different types of cinemas apart from the automatic increase with increased admission prices. In the smaller size-groups a high proportion of cinemas are exempt from duty and levy altogether, most of them because they have less than 400 seats and are situated in rural areas, but a few because they are operated for certain cultural purposes or in connection with welfare facilities in mining villages. Table 17 shows the differences between these types of cinemas. News cinemas and a very small number of other specialist cinemas are excluded since their experience is not comparable with the rest.

TABLE 17

Admissions and Distribution of Takings in Small Cinemas, January–March, 1951

		Up to 250 *seats*		251–500 *seats*	
	Unit	*Tax-exempt*	*Other*	*Tax-exempt*	*Other*
Number of seats	'000	26·9	6·6	92·2	270·6
Number of admissions	,,	983	476	4,655	18,098
Admissions per seat	Number	37	72	51	67
Gross takings	£'000	65·3	32·7	310	1,187
Tax(*a*)	,,	—	10·3	—	384
Net takings	,,	65·3	21·3	310	803
Film hire	,,	21·5	6·5	109	254
Exhibitors' share	,,	43·8	14·8	201	548
Average admission price	Pence	15·9	16·5	16·0	15·7
Film hire as proportion of net takings	Per cent.	32·9	30·5	35·1	31·6
Exhibitors' share per seat	£	1·63	2·24	2·18	2·03

(*a*) Including payments to British Film Production Fund.

From this table it will be seen that in these small cinemas (up to 500 seats) exempt cinemas are able to charge admission prices not very different from the others, but the latter suffer a deduction of nearly a third in arriving at their net revenue. This difference goes some way to compensate for the much lower rate of admission in exempt cinemas.

Film Hire

The methods of fixing charges for the hire of films were set out and discussed in detail in the *Plant Report on Distribution and Exhibition of Films* (Cmd. 7837, paras. 112–136). Briefly, the hire of first feature films is normally covered by a payment calculated as a percentage of net box-office receipts, after making an allowance for the hire of the supporting programme. (The latter may be obtained either on a percentage basis or for a flat-rate payment). The percentage payment is usually fixed according to a sliding scale, good attendances attracting a higher percentage in accordance with various " break-points " specified in the agreement between the renter and the individual exhibitor. Early in the war the Cinematograph Exhibitors' Association sought to protect the interests of its members by securing their agreement to a limitation of the percentage they would agree to pay for any one film, the limit being fixed at 50 per cent. That limit has been generally effective ever since.

In view of the comparative rigidity imposed on admission prices until recently by the scale of entertainment duty, the film hire element in the determination of the exhibitors' share has been the one most amenable to the influence of management policy. It has been shown by the Board of Trade enquiries that the average for film hire in recent years has been about 35 per cent. of net takings. The objective of bookers has no doubt been to obtain the best films they could within this limit—a difficult task when many films on general release command a higher rate.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

With their higher prices and larger attendances the bigger cinemas have been able to extend the limit somewhat, paying in recent years up to 37 to 38 per cent. of their net receipts in film hire. (Although it is curious that the largest cinemas of all, with more than 2,000 seats, pay a rather smaller proportion of their takings in film hire than the average). On the other hand smaller cinemas have had to avail themselves of the cheaper rates for inferior films and flat rates for old films so as to reduce their expenditure to about 32 per cent. or less. (The low rates in news cinemas are, of course, a special case.) These proportions are less than in the boom years immediately following the end of the war. For 1947/48 it was reported to the Plant Committee that the proportion was 39.3 per cent. in 1,656 cinemas, but these cinemas were heavily biased in favour of the larger ones. For the same cinemas the rate of film hire in 1938/39 was 37.8 per cent. of net takings. In 1950, however, the average proportion of net receipts paid out in film hire by all cinemas was 35.5 per cent., in 1951 35.3 per cent., and 35.1 per cent. in 1952. Only in cinemas with between 1,500 and 2,000 seats was the average film hire proportion in 1952 as great as the figure given above for 1938/39. Film hire rates therefore appear to have risen between the beginning and end of the war, but have since declined to a point lower than the pre-war level.

It has already been noted that the large circuits contain a high proportion of large, first-run cinemas, and it is not therefore surprising to find that their film hire is relatively high. (Low film hire in a few exceptionally large cinemas has only a slight modifying effect on this average). In the first quarter of 1951, when film hire for all cinemas absorbed 34·8 per cent. of net takings, the proportion for the largest circuits was 36·3 per cent. It seems reasonable to expect that the small and medium circuits would contain a high proportion of second-run halls left over, as it were, by the larger ones. This expectation seems to be borne out by the film hire figures, for the proportion for all other circuits is below average, tending to vary inversely with the size of the circuit to which cinemas belong. As in other fields, it appears that the large buyer can obtain more favourable terms than the small.

There is, however, another factor. In paras. 24 and 25 of their report the Plant Committee described the operation of the "barring" system whereby a cinema hiring a film for exhibition in a particular week ensures that the same film is not shown in the same district until after the lapse of a specified time—normally two weeks. This system has the effect of actually delaying the second showing of films in some areas for a much longer period, the available copies being first circulated in the surrounding districts, while second-run cinemas tend to confine their attention to older and cheaper films. These cinemas are, of course, normally outside the large circuits. Consequently there is a relatively wide divergence in the rate of film hire between large circuit cinemas and others in regions where the circuits are strong. In London and the South-East in the first quarter of 1951 large circuits paid in film hire 35·3 per cent. of net receipts, but other cinemas paid only 28·7 per cent; and in the Southern region the proportions were 37·2 and 33·5 per cent. On the other hand, in the Northern region the proportion of net receipts going in film hire was 37·2 per cent. for large circuit cinemas and 35·4 per cent. for others and in Wales 37·0 per cent. and 36·2 per cent. respectively. The proportion in the latter regions is fairly high because film hire is measured against a low level of takings. In absolute terms film hire is fairly low, being to a considerable extent fixed at flat rates.

Some indication of the extent to which the film hire figures are affected by the showing of old films, obtainable at cheap rates, is given in Table 18. The data on which this table is based relate to 821 of the cinemas shown in Table 9 as having a 6-day programme. The films shown in these cinemas in the two weeks March 11th–17th and September 23rd–29th, 1951, were classified according to the period that elapsed between their date of registration and the week of exhibition. The two sets of figures were then added together and the proportions in the three age-groups calculated.

TABLE 18

Age of Films Shown in 821 *Cinemas*

	0–6 *Months*	6–12 *Months*	*Per cent. Over* 12 *Months*
4 Northern Regions .	62	28	9
London and South-Eastern	94	3	3
Rest of Great Britain .	73	19	7

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

These figures relate mainly to larger cinemas, with a high proportion of first-run halls and of those in London. For the remainder the proportion of older films is certainly much greater than shows in the table, and the results for the provinces, and especially the north, would be affected much more than for London. To some extent, of course, the figures in the first two columns reflect the time it takes for a film to reach all districts after its general release in London. Nevertheless the last column, considered in relation to the qualifications which must be made, indicates that the proportion of cinemas in the regions of low admission price which show old films is several times as large as in London. This goes far to explain on the one hand the low admission charge and on the other the difficulty of exhibitors in these regions in reducing further their film hire payments.

Looking at the incidence of film hire in the regions, therefore, there are two conflicting tendencies at work—the influence of large circuits pushing the charge up and the barring system keeping it down in the same regions—while the relative magnitude of total revenue naturally affects the result when expressed as a percentage. Hence the proportion of net receipts paid in film hire in London and the South-East is one of the lowest regional figures (only 33·0 per cent. in the first quarter of 1951) whereas that in Wales is one of the highest (36·3 per cent.), the remainder forming no readily recognizable pattern. In towns with more than 100,000 inhabitants, which account for almost half of total net revenue, the proportion paid in film hire was only 34·2 in the year ended March, 1951, while in other areas it was 36·2 per cent.

Exhibitors' Share

The last column in Table 16 shows the net effect of the various factors so far discussed. Once again we find that there is a fairly even progression in the exhibitors' share per seat analysed by the size of cinema. If news theatres, etc., are excluded the figures for the two smallest size groups become £1·75 and £2·06 respectively. At this stage there is no important distinction between tax-exempt cinemas and others of comparable size. The effect of relatively high expenditure on film hire in the small cinemas has done little to lessen the disparity between the revenues of small and large halls—the largest enjoy a revenue per seat which is nearly $2\frac{1}{4}$ times that of the smallest.

The situation is similar when we look at the circuits—the larger the circuit the higher the revenue. Breaking these figures down by regions we have found that the large circuits earned in the first quarter of 1951 more than £3 per seat in all regions except Scotland, while other cinemas earned less than £3 per seat everywhere except London and the South-East. There the figure for "others" was actually higher than for the large circuits, but the excess can be accounted for by the relatively large number of news and specialized theatres in London.

Turning to the regions, the revenue per seat is considerably higher in London and the South-East than elsewhere. This is mainly due to the very high figures for Central London and in the remainder of the region the figure is not very different from that in the Southern and South-Western regions. Once again there is a sharp distinction between south and north. In the quarter to which the figures in Table 16 relate the four northern regions had a seat revenue on the average ten shillings, or one-sixth, lower than in the rest of the country, but the gap is less than that in the average price or in the gross takings per seat. There is an interesting difference between Wales and the South-West, in both of which regions cinemas are generally small and the rate of admission low. In Wales the average admission price is low and the exhibitors' share per seat the lowest in the country; in the South-West the admission price is high and the exhibitors' share also one of the highest. The fashionable high price in the latter region therefore seems to be good business, and it is at least doubtful whether a lower price would attract enough extra patrons to make up for the loss of revenue.

The average price paid by children for admission to their special performances in the summer of 1950 was 5·9*d.* and in the spring of 1952 6·1*d.* In the former period 10 per cent. of gross takings was taken in entertainment duty, but as a result of an extension in September, 1950, of the price limit at which admissions were exempt from duty, the duty proportion in 1952 was only $1\frac{1}{2}$ per cent. Film hire payments increased by 6 per cent. between the two periods, but the effect of this was hidden by the increase in the number of admissions and the price and the decrease in the tax proportion. The exhibitors' share from childrens' performances increased between the periods mentioned from £180,000 to £227,000. For each admission in 1952 the exhibitors'

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

share was 4·1*d*, which may be compared with 8·3*d*. for all other admissions in the same period. Having regard to general running costs (though we understand these to be proportionally less for children's performances than for others) it would appear that the financial gain from running these shows must be little or nothing, particularly in view of the probability, previously referred to, that some of the children would go to ordinary performances if special ones were not provided. Nevertheless it seems likely that these special performances have considerable importance in transforming the ordinary child's desire for cinema-going into the habit which is so marked a trait among the majority of young men and women. To a considerable extent therefore these performances represent an investment in the future rather than a currently profitable activity.

The conclusion on Sunday performances is rather different. In the fourth quarter of 1951 gross takings on Sundays amounted to £3,045,000. The average price on Sundays was 22·6*d*. compared with 19·8*d*. for all other admissions or about 20·4*d*. if admissions to children's performances are omitted. The higher average price follows from the fact that cinemas are usually fuller on Sundays than is usual in the rest of the week and that consequently the higher priced admissions form a bigger proportion of the total than the average for the rest of the week. But this high rate implies a high incidence of tax, and entertainment duty and the Eady levy together account for a deduction of 41·6 per cent. of gross takings, leaving £1,777,000 net. Further, it is a normal condition of licensing authorities in permitting Sunday opening that a proportion of the takings should be given to charity. In the fourth quarter of 1951 the total amount so paid was £110,000, or 6·2 per cent. of net takings. These additional outgoings, however, were more than outweighed by economies in amounts paid for film hire. At £302,000 these represented 17 per cent. of net takings which may be compared with 36·4 per cent. for all other performances in that quarter. As a result the exhibitors' share after making charity payments was £1,365,000 or 10·1*d*. per admission, compared with 7·9*d*. for all other admissions. However, as we shall see, wages absorb on the average about 23 per cent. of total net takings, and on Sundays cinema staff are normally paid twice their ordinary rate of wages. Applying these ratios to the figures for the fourth quarter of 1951 we conclude, on a rough approximation, that for each admission the exhibitor had on the average about 4*d*. after paying film hire, charities and wages, whereas for week-day admissions he had about 5*d*. Making allowance for the higher rate of admission on Sundays we have found that the profitability of a Sunday performance is not very different from an average week-day performance—on the average it is very slightly greater—in spite of considerable differences in the incidence of different items of cost. Regional variations are, however, considerable, mainly because of differing rates of Sunday admissions. In Scotland, Sunday business is much less profitable than week-day, and in London and the South-East significantly less so; in all other regions except Wales and the South-West it is substantially more profitable.

Before considering in further detail the adequacy of the exhibitors' share we need to review the available information about the costs which it must cover. This may be done under three heads: (i) Employment and remuneration; (ii) Other costs, except rent, and (iii) Rent.

(i) *Employment and Remuneration*

Table 19 shows the numbers employed in cinemas (excluding those employed in restaurants attached to cinemas) at various dates.

TABLE 19

Number of Persons Employed in Cinemas

	Full-time		*Part-time*		
Date	*Male*	*Female*	*Male*	*Female*	*Total*
July 1st, 1950 .	26,739	26,873	6,992	25,369	85,973
June 30th, 1951 .	25,393	24,768	7,268	28,516	85,945
June 28th, 1952 .	25,376	24,616	7,200	29,201	86,393
March 28th, 1953 .	24,642	22,892	7,232	28,230	82,996

The total number of persons employed remained fairly constant until 1953, but the proportion employed on a part-time basis (i.e., working not more than 30 hours a week) has increased from

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

38 to 43 per cent. (For females the proportion has increased from 49 to 55 per cent.). This shift from full-time to part-time has mitigated the effect of wage increases in the industry resulting from new wages agreements. Particulars of wages paid were collected for the last quarter of 1950 and for a week in the first quarter of 1952 and it was found that the total increased from £3,770,000 to a quarterly rate of £4,188,000 between these two periods, accounting for about 23 per cent. of net takings in each case.

TABLE 20

Cinema Wages (a) *Paid in First Quarter of* 1952. *Analysis by Size of Cinema*

Size of Cinema (Number of Seats)	*Wages Paid* (£'000)	*Seats* ('000)	*Wages per Seat* (£)
Up to 250	27	32·6	0·83
251– 500	325	346·6	0·94
501– 750	600	655·1	0·92
751–1,000	738	779·7	0·95
1,001–1,250	642	654·0	0·98
1,251–1,500	452	450·5	1·00
1,501–1,750	448	422·0	1·06
1,751–2,000	408	478·1	1·08
Over 2,000	549	481·3	1·14
Total	4,188	4,199·9	1·00

(a) Excluding wages paid at head-offices and in restaurants.

The wages cost per thousand admissions shows a wide diversity between different regions. In the first quarter of 1952 it ranged from £10·0 in the Northern region to £15·1 in the Southern and the London and South-Eastern regions. The figure was high throughout the Home Counties but low in those regions that thave a low admission price, suggesting that one of the amenities which the public gets for a high charge is a high standard of service. The number of staff required however, is largely conditioned by the size of the cinema. The average wage cost per seat in the quarter was £1, and although this cost increased with the size of cinemas it was only for the smallest and largest cinemas that it differed by more than 8 per cent. The figures are shown in Table 20. Although these estimates are based on figures for only one week we have no reason to doubt their substantial accuracy.

(ii) *Other Costs, Excluding Rent*

There has been no Board of Trade enquiry into costs other than wages and salaries. In 1952, however, Messrs. Stoy Hayward & Co., accountants to the Cinematograph Exhibitors' Association, prepared a report in which cinema costs were analysed on the basis of returns collected from a sample of cinemas covering the year ended June 30th, 1952. Out of 651 questionnaires sent out 376 were returned, the response rate rising progressively from 19 per cent. for the smallest cinemas to 91 per cent. for the largest. Consequently the figures for the largest cinemas were probably more representative than those for the smaller ones, although we were informed that the results obtained from control questions on the numbers of seats and admissions were reasonably satisfactory for all size groups. The cost figures per seat are shown and summarised in the first two columns of Table 21 and it will be observed, from a comparison of column 1 with the preceding table, that while the results for cinemas with more than 1,500 seats are slightly lower than those obtained by the Board of Trade the rate of wages for cinemas up to 1,500 seats is generally higher. This may be due to a bias in the returns arising from psychological as well as from purely statistical factors.

Other costs, as ascertained from this inquiry, conform to the now familiar pattern, increasing with the size of cinema. It seems likely, however, that these figures also are biased in some degree in the same way as the wages figures, and in the absence of any other corrective data we have assumed that these costs have been inflated for the smaller cinemas in about the same proportion as wages. Working on this basis the last three columns of Table 21 show adjusted estimates

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

for seat costs in the case of cinemas with less than 1,500 seats which may be more realistic than the figures originally obtained, but the effect of the adjustment is probably to set a lower limit to total costs. An upper limit is likely to be found by adding the adjusted wages figures to Messrs. Stoy Hayward's original estimates of " other costs." This would represent an average for wages and other costs at all cinemas of about £8·7 per seat per year, against £8·3 on the fully adjusted basis.

TABLE 21

Estimated Cinema Costs per Seat (Excluding Rent) for Year ended June 30th, 1952

	£				
	Original Sample Basis		*Adjusted Basis*		
Number of Seats	*Wages*	*Other Costs*	*Wages*	*Other Costs*	*Total*
Up to 250 . .	4·21	4·16	3·3	3·3	6·6
251– 500 . .	4·55	4·15	3·7	3·4	7·1
501– 750 . .	4·56	4·30	3·7	3·5	7·2
751–1,000 . .	4·41	4·39	3·8	3·8	7·6
1,001–1,250 . .	4·42	4·83	3·9	4·3	8·2
1,251–1,500 . .	4·30	4·91	4·0	4·6	8·6
1,501–1,750 . .	4·14	4·87	4·1	4·9	9·0
1,751–2,000 .	4·23	5·18	4·2	5·2	9·4
Over 2,000 . .	4·42	5·87	4·4	5·9	10·3

(iii) *Rent*

Although rent, real or imputed, is evidently one of the major costs to be met by the exhibitor it is very difficult to form an idea of its amount. Making certain assumptions about the original capital costs per seat for cinemas in each size group, Messrs. Stoy Hayward arrived at a total capital cost of all cinemas of £95 million. They argued that, while an ordinary landlord would look for a return of 6 per cent. on his investment, a cinema landlord would look for more than this because of the immobility of his invested capital, and suggested a figure of 8 per cent. Against this it might be argued that restricted user possibilities for a cinema building would make it difficult for the landlord to maintain a high rent in the straitened circumstances of the industry. On the other hand an economic rent would need to be fixed in the light of current rather than historical values. Accordingly the original capital costs might have to be multiplied by 2 or 3 on account of increased costs of construction ; but a deduction would have to be made for obsolescence. In any case there is no information about the extent to which exhibitors own their cinemas, clearly an important point in considering the actual charge for rent. The following figures suggested by Messrs. Stoy Hayward ignore differences in the charge as between owner-exhibitor and others —which may be justifiable on the ground that some rent should be charged whatever the circumstances.

TABLE 22

Estimated Rent Charge in 1951/52

Size of Cinemas (Seats)	£'000
Up to 250	44
251– 500	499
501– 750	996
751–1,000	1,247
1,001–1,250	1,099
1,251–1,500	829
1,501–1,750	846
1,751–2,000	847
Over 2,000	1,194
Total	7,601

With the information now given we can revert to the exhibitors' share and see how it has varied in recent years. In Table 23 are set out the amounts of exhibitors' share for each size group of cinemas in the first quarters of each year from 1950 to 1952. In the fourth column is given an estimate of costs, excluding rent, for an average quarter in the year ended June 30th,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

1952, which is calculated on the basis of the figures in the last column of Table 21. (If Messrs. Stoy Hayward's figures for " Other costs " were taken, as suggested above, the total of this column would be about £420,000 greater). The final column shows the relationship between the exhibitors' share and estimated costs. News theatres are excluded throughout.

TABLE 23

Exhibitors' Share and Estimated Costs, 1950–1952. *Analysis by Size of Cinema*

Size of Cinema (Seats)	*Amount of Exhibitors' Share Periods January–March* 1950 (£'000)	1951 (£'000)	1952 (£'000)	*Estimated Costs Excluding Rent, Year ended June 30th, 1952 (Quarterly Average)* (£'000)	*Exhibitors' Share as Proportion of Costs (Per cent.)*
Up to 250	61	57	62	52	119
251– 500	732	742	776	598	130
501– 750	1,463	1,498	1,526	1,173	130
751–1,000	1,813	1,908	1,932	1,481	130
1,001–1,250	1,682	1,711	1,709	1,341	127
1,251–1,500	1,261	1,269	1,241	969	128
1,501–1,750	1,406	1,284	1,289	950	136
1,751–2,000	1,221	1,212	1,223	889	138
Over 2,000	1,811	1,775	1,723	1,239	139
Total	11,449	11,455	11,480	8,692	132

From this table it will be observed that revenue in the first quarter of 1952 exceeded total costs other than rent by about 30 per cent. in most groups. The excess was only 19 per cent. in the group of smallest cinemas, and 39 per cent. in the largest. The case of the smallest cinemas, however, is not quite comparable with that of others. For the most part they are in rural districts and the number of performances they give is limited: hence they may be run in conjunction with some other business by which they may be effectively subsidized, or as a form of social service on a non-profit basis. It is of course also possible that the rent charge for these cinemas is in some cases only nominal. It is noteworthy that the revenue of these smallest cinemas has recently been increasing while that of large cinemas has been declining.

Messrs. Stoy Hayward suggested in their report that a reasonable amount of profit for exhibitors would be 10 per cent. of their gross takings. The basis of this assessment may perhaps be questioned. Profit might preferably be related to the number of seats. If it is reckoned as a proportion of takings it may be argued whether that part of takings represented by tax should be included in the calculation. Moreover, the level of profit that is reasonable depends on the extent to which a return on invested capital has already been included in the rent charge. Nevertheless, it is of interest that in the year ended June 30th, 1952, profits on Messrs. Stoy Hayward's assessment would have averaged £2·7 million a quarter, about equal to the total difference between the exhibitors' share in the first quarter of 1952 and a quarter's costs as shown in Table 23. Even on this basis, therefore, the existing revenue of the industry as a whole was, in fact, just about adequate for all purposes except the payment of rent. In addition, however, exhibitors were able to supplement their revenue by the sale of refreshments, and particularly of ice-cream, to their patrons and also from the exhibition of advertisement films and slides.

Cinema Sales

Information about the value of sales in cinemas was collected by the Board of Trade for the second quarter of 1951, and the results are set out in Table 24. The figures exclude about 50 small cinemas from which no returns were received, but the deficiency is probably considerably less than 1 per cent. of the aggregate for all cinemas, and is therefore ignored here. The figures also exclude 387 cinemas in which sales are made through concessionaires, and revenue derived from the operation of restaurants, of which there were 498.

This table demonstrates the principle that to him that hath shall be given. The average value of sales for each admission in the quarter was 2·5*d.* but the average increased with the size of cinema. Whereas the average for the smallest cinemas was 0·8*d.* (although sales here are

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 24

Receipts from Sales of Tobacco, Ice-cream, etc., in Cinemas in which Direct Sales were made, April—June, 1951

	Total Cinemas (Number)	*Tobacco Sales*		*Ice-cream, etc., Sales*		*Total Sales (Receipts) (£'000)*
		Cinemas (Number)	*Receipts (£'000)*	*Cinemas (Number)*	*Receipts (£'000)*	
A. *Analysis by size*						
Up to 250	165	11	0·8	66	5·9	6·7
251– 500	897	260	36·2	600	118·4	154·6
501– 750	1,043	382	62·2	806	264·5	326·7
751–1,000	895	484	102·8	742	402·2	505·0
1,001–1,250	589	384	102·5	524	420·5	523·0
1,251–1,500	334	256	91·8	305	358·3	450·1
1,501–1,750	264	225	90·9	245	395·2	486·1
1,751–2,000	206	182	74·8	199	355·8	430·5
Over 2,000	204	185	108·8	194	506·7	615·4
B. *Analysis by circuit*						
Singleton cinemas	1,556	481	87·2	1,054	305·4	392·6
Circuits with						
2–10 cinemas	1,230	475	95·6	911	379·9	475·6
11–50 „	663	344	82·6	588	387·3	469·9
Over 50 „	1,148	1,069	405·3	1,128	1,754·8	2,160·1
C. *Analysis by region*						
Scotland	603	234	59·3	408	251·1	310·4
Northern	423	151	41·6	312	185·7	227·3
East and West Ridings	459	212	59·2	363	212·0	271·2
North-Western	715	316	71·7	611	353·3	425·1
North Midland	332	168	37·6	275	160·8	198·4
Midland	368	235	51·9	301	280·1	332·0
Eastern	224	149	42·1	202	149·4	191·5
London and South-Eastern	664	509	181·4	599	835·3	1,016·7
Southern	201	154	51·2	174	163·3	214·5
South-Western	256	149	42·0	207	133·9	175·9
Wales	352	92	32·8	229	102·6	133·3
Great Britain	4,597	2,369(*a*)	670·7	3,681(*a*)	2,827·5	3,498·2

(*a*) The number of cinemas making direct sales of any kind was 3,698, only 17 selling tobacco but not ice-cream, etc.

slightly understated because of some missing returns), that for the largest was 3·4*d.*; for singleton cinemas the figure was 1·3*d.* but for the large circuits 3·7*d.* In the Home Counties, where admission prices are high, sales were over 3½*d.* a head; in the north, apart from the North-Western region and in Wales, where prices are low, they were less than 2*d.* Assuming that an individual sale represents about 6*d.* these figures suggest the remarkable conclusion that on the average practically every other person who went to the cinema at this time bought some kind of refreshment—mostly ice-cream. Yet there is some scope for more sales. About one cinema in nine has no sales facilities. The table shows that this minority is relatively larger among small cinemas, singletons and those in small circuits, while only about two-thirds of the cinemas in Scotland and Wales make direct sales.

There is no information about the revenue derived by cinemas from concessionaire sales. Nor is it known how far the second quarter's figures were representative of a whole year's sales; although this quarter's admissions was close to the average for the year 1951, seasonality in cinema sales is probably different from that in admissions. Moreover, no inquiry has been made about the terms upon which cinemas obtain their supplies, and no reliable estimate can be made of the margin obtained on sales. Nevertheless it is clear that the profit on a turnover of £3½ million in three months must have made a very substantial contribution towards the total revenue of the trade.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Since 1951, however, there have been two important developments. First, as we have seen, there has been a falling off in admissions which in 1952 was at the rate of about 4 per cent. This doubtless would have had a proportionate effect on cinema sales, other things being equal. But we have suggested that some of this decline was due to financial economies practised by the public. This being so it may be surmized that the decline in expenditure on ice-cream would be greater than in the number of admissions. The second development has been the cessation of sweet rationing. While this was in force virtually no confectionery could be sold in cinemas; it was impracticable to handle coupons in the dark. But with sweets freely available there must have been a considerable switch of consumer preference from ice-cream to confectionery, and it is probable that this has had an adverse effect on profit margins.

Screen Advertising

A fairly accurate assessment of the importance of revenue from the showing of advertising films and slides can be made for 1948 and 1938. In 1948 the total expenditure by advertisers on the distribution and exhibition of advertising films and slides amounted to £2,190,000 compared with £570,000 in 1938. It is not possible to say what proportions of these sums represented revenue to cinemas, but a figure of £1¾ million in 1948 does not seem unreasonable, and it seems clear that revenue from this source in 1948 was four times what it was in 1938.

Conclusion

In 1935 Rowson mentioned the anxiety felt at that time that there might be redundancy in the provision of cinemas. Then, as now, there was talk about the uneconomic state of the industry, and it seems likely that there were many exhibitors then who were finding it difficult to carry on. Indeed we have discussed the evidence that a number of medium-sized urban cinemas were forced out of existence, their place being taken by luxury houses largely under the control of circuits. These ills were, however, forgotten in the war-time boom in film exhibition when cinema audiences were swollen as a result of inflation in our economy. It was inevitable that, when these conditions came to an end, there should be a sharp contraction and the effect of this was still being felt to some extent in the period with which we have been mainly concerned, from 1950 to 1952. By the end of that period, however, deflation had almost, if not quite, exhausted its influence in the decline in cinema admissions and its place had been taken by an even more formidable and less transitory factor—television. Admissions continued to fall and, although takings were maintained through higher prices, increased costs absorbed the additional money. Profits of some cinemas may have been inadequate in 1951, when they could only be made up to a satisfactory total by the sale of ice-cream to their patrons; in so far as the later and steeper decline in admissions has been accompanied by a parallel decline in sales, profits will have been adversely affected and may have been further diminished by a contraction in the profit margin.

It is at this point that " 3 D " emerges to throw a gigantic shadow over film affairs. There can be little doubt now that a new shape is to be given to the films we are offered. Although we cannot yet tell which particular device will be generally adopted it is practically certain that large capital outlays will be needed to adapt cinemas and a new squeeze will develop for those exhibitors who cannot produce the necessary finance. Further, there are many cinemas which are already obsolescent and the new conditions may well drive some of them into decay. In short, the industry is back in much the same financial condition that existed twenty years ago. What solution to its problems will be found or at what level its business will be carried on it is too early to speculate. What is, however, sure is that films are a living and potent force which will not be easily quenched. The present situation is but a stage in the evolution of the cinema.

Summary

The cinema in Great Britain accounts for over four-fifths of all entertainment admissions subject to entertainment duty and is the cheapest form of mass entertainment. Public patronage increased rapidly during the war. Although it has since declined, the number of admissions per head in 1952 was still as high as 27 compared with 20 in 1934 and was higher than in any other country.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In the mid-thirties many small urban cinemas, obsolescent and inadequately financed, were being replaced by large luxury cinemas organized in circuits. The number of seats in relation to the adult population has not changed since 1934. These circuits have extended their influence outwards from London and remain weakest in the north and in Wales. There is a close connection between the size of circuits and the size of the cinemas they own; the large circuits (over 50 cinemas) have nearly 40 per cent. of all seats, and own over three-quarters of the largest cinemas (over 2,000 seats). Circuit influence largely accounts for the prevalence of the double-feature programme and the six-day run, which are more common in the south than in the north.

Cinema patrons are drawn largely from the younger age-groups and the lower income classes. Most of them see films regularly and indiscriminately. People go to the cinema more in the north than in the south, and more in town than in country. Sunday opening is normal in the south, less usual in the north and exceptional in Scotland and Wales. Children's club performances have been increasing rapidly under circuit influence. There is marked seasonality in cinema-going, modified by holiday business at seaside resorts, with a high first quarter and low final quarter in each year. Between 1950 and 1952 about three-quarters of the decline in admissions can possibly be attributed to the competition of television, the remainder being due to economies practised by the public, which had been the main cause of the immediate post-war drop in cinema business.

Admission prices increase with the size of cinema and costs generally vary in the same way. Large circuits account for nearly half of all gross takings. Most cinemas supplement their film revenues by ancillary earnings, especially from the sale of ice-cream, etc., and the showing of advertisement films. Sales in cinemas amounted to nearly £3,500 000 in the second quarter of 1951, representing a purchase by practically every other cinema-goer in that period. These sales may have declined since then. It is uncertain how far existing finances are adequate for probable new developments in the industry.

Acknowledgment

Tables 1, 9, 10, 17 and 25 are wholly or in part Crown Copyright, and their inclusion here is by courtesy of H.M. Stationery Office.

References

Board of Trade
Report on the Distribution and Exhibition of Cinematograph Films (1949); Cmd. 7837. H.M.S.O.
Board of Trade Journal, "Statistics of British Film Industry", **158**, 978; **159**, 360, 841; **160**, 425, 1103; **161**, 477, 1284; **162**, 481, 1204; **163**, 398, 1039; **164**, 411, 1102; **165**, 534.
Box, Kathleen (1948), *The Cinema and the Public*. London: Central Office of Information.
Hobson, J. W., and Henry H. (1952), *The Hulton Readership Survey*. London: Hulton Press.
Motion Picture and Television Almanac (1953), New York: Quigley Publications.
P.E.P. (1952), *The British Film Industry*. London: Political and Economic Planning.
Rowson, S. (1936), *J.R. Statist. Soc.*, **99**, 67.
Silverman, R. (1951), *Advertising Expenditure in* 1948. London: Advertising Association.
Ward, J. C. (1949), *Children and the Cinema*. London: Central Office of Information.

Discussion on Messrs. Browning and Sorrell's Paper

Mr. Leslie T. Wilkins: I have much pleasure in proposing a vote of thanks to Mr. Browning and Mr. Sorrell for their paper. My main qualification for criticism is that I know nothing of the aspects of the cinema industry covered by the writers, and can, therefore, make the quite conventional criticism that the paper does not cover those aspects of the subject which I regard as important, and which the authors doubtless regard as outside their scope. This may be unfair, but it is perhaps meaningful. The paper might afford good guidance to a Chancellor of the Exchequer, but its value in other respects I find difficult to appreciate.

This is not a point for which we may hold the authors responsible, but it is worth mentioning because it has a wider and more general effect. When a problem has to be solved and when data are available as a by-product of some administrative process, there isoften a tendency to force these available data into services for which they are basically unsuitable. This sort of error is illustrated by the authors' treatment of television. They have fallen into a fairly common fault: "Here is a problem—what data have we available—let us use it as best we can." A better approach, I think, would be: "Here is a problem—what data do we need to solve it—how can

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

we get just enough to solve the problem with sufficient precision?" Whilst it is undoubtedly useful to have a body of all purpose data, this fact should not be allowed to dominate our approach to all sorts and conditions of problems.

There are also a number of small points in the detail of the text I should like to raise.

The phrasing on p. 156, second paragraph under *Film Hire*, is unfortunate. We are told that the average payment for film hire is 35 per cent. of takings; then, a little further down, that the objective of bookers is to obtain the best within this limit. The concept of the average as a limit I find a little difficult. I think this should be changed, otherwise we shall get a further series of correspondence like that recently in *The Times*.

I think that some measures of dispersion mixed up with the rather large dose of averages we have had would have been more informative.

On p. 159 I suspect another unfortunate phrasing. I do not see how the fact that cinemas are fuller on Sundays necessarily results in a higher average price per seat. This assumes a different proportional distribution of admissions by price on Sundays. Is the proportional distribution of seats/prices a function of the demand? If so, the phrasing is explained, but I cannot agree that the interaction is self-evident, especially as the times of opening are also restricted on Sunday.

On p. 133, the authors state that the response rate has always been more than 99 per cent. There are, however, at least two tables (Tables 18 and 24) based on much less than this proportion of the total. It is significant that the former refers to the age of the films shown and the latter to additional earnings.

On a general point, it is not always clear whether the attendance figures (in particular I have in mind Table 6) include or exclude Sunday attendances and special children's admissions. It would make the tables easier for inexperienced readers to follow if this fact were always specifically stated where appropriate.

Table 3 gives admissions per head of population. I cannot help wondering whether, if corrections had been made for the differing age distributions, the picture might not change to some extent. I think the United States figures would be more interesting if we had separate figures for coloured and white populations.

There are a few more unanswered questions in the section headed *The Cinema-going Habit* (p. 145). For males, at least two years are taken up by National Service during the peak age of attendance. During this time the exposure to risk of attendance at a civilian cinema for this group is considerably reduced. I cannot ascertain how this fact has been taken into account either in the Hulton Readership Survey or by the authors of this paper.

The Social Survey Report *Children and the Cinema* was based on data collected in the field in November, 1948. I am particularly interested to note that the authors consider the estimate of attendance derived then to be low. This raises a rather interesting question—whether the age distribution of cinema attendance might not vary with the time of year. The authors certainly show what appears also to be a rather unusual seasonal variation. Could not some of this be due to early darkness inhibiting the attendance of the younger age-groups, but stimulating that of the older?

These are all relatively minor points, and my main criticism concerns the authors' methods in assessing the effect of television on cinema attendance. One of the questions in an old examination paper of this Society showed two sets of time series figures—one relating to television licenses and the other to the number of persons committed to mental institutions. The examinees were asked to work out the correlation—obviously somewhere about $+ 0{\cdot}9$—and to comment on their results. So far as I can judge, in the minds of quite a number of people connected with the film world there would have been only one obvious interpretation—which I do not think would have been accepted by the examiners.

The method of argument from concomitant variation, especially when so few points are involved, is surely dangerous. Perhaps it is the more dangerous because the authors have, I fear, derived at least a reasonable answer. Table 2 shows that dog racing and other sports attendance has declined more steeply than that of cinema attendance. Has television affected these more than it has the cinema? Can it be assumed that television has had no effect on the theatre and music-hall? Admittedly, the authors have taken some steps to separate their problem, but I wonder why they used a moving average rather than, say, a least squares fitting? What levels of significance would they have obtained if they had tested such a fit? I notice also, with some apprehension, that they start at a seasonal high, and stop their analysis at a seasonal low. This, of course, enhances the appearance of the downward slope. I wish that they had not obtained such an apparently reasonable result from what I believe to be such unequal methods of analysis.

Nevertheless, I certainly wish to thank the speakers, on behalf of this Society, for giving us such a detailed paper, and also for the release of some data which have not appeared elsewhere.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Mr. EMMETT: Some of the things I had in mind to say have been covered to some extent by Mr. Wilkins. I do not think, however, that there is any harm in my saying them again in a slightly different way.

Much of the information contained in this paper has, as the authors themselves say, been presented elsewhere, in the *Board of Trade Journal*, and in the reports of the results of sample surveys. However, a comprehensive source of information on cinemas and cinema-going has, I feel, been needed for a long time and the authors are to be congratulated on bringing together in one paper a remarkable quantity of data of a diversified character about what is the major source of popular entertainment in this country at the present day.

Where the authors are dealing with an analysis of the returns which the Board of Trade are collecting, it seems to me that they have been very thorough and comprehensive, though personally I am sorry to see such a sketchy approach to the cinema audience section of the paper. There are so many pertinent questions which are not touched upon. For instance, how many persons never go to the cinema? Is the decline in admissions in recent years due to an increase in the number who never go, or is there also an attenuation in frequency of attendance amongst those who go there very often. Is the decline more noticeable in one section of the community than another? How do attendances vary from one day of the week to another, and from one time of day to another? These and many other questions about attendance and the audience for the cinema I feel should be mentioned, even if not answered, in any paper dealing with the cinema audience.

Then there is a very large section of the paper dealing with costs. I somewhat hesitantly suggest that one-third of the paper is too large a proportion to give to this, especially if it means the exclusion of other information which I personally would consider of greater importance.

I should like now to turn to some specific points.

Could the authors tell us something of the nature of the return on which so much of their paper is based. All we know is that it is made quarterly.

I should also like to know something of the estimation process which before 1950 was used to derive the figures in Table 1.

Next, a very small point. The paragraph following Table 2 seems to have rather a curious ring about it. The authors say that the pre-eminence of the cinema in the field of taxable entertainment is not unconnected with the low mean admission price, but this will surely be a minor factor. From Table 2 it will be seen (by dividing takings by admissions) that four, or possibly five, of the other taxable entertainments mentioned have mean admission prices not very much greater; the cinema is the lowest by perhaps a matter of twopence or threepence.

On p. 137 comes a more important point. The authors admit that the admissions per head of the population figures in Table 6 will necessarily overestimate the attendances of persons in towns, since the cinemas there serve, to varying degrees, the surrounding countryside. However, on two subsequent occasions—one in the conclusions—they categorically state that persons living in large towns go to the cinemas more often than those living elsewhere. Is this true? A great deal of research has been carried out into what we know as the hinterlands of various marketing centres—large centres of population. Already, before the war, Professor Green had done much in this field, identifying some seven or eight hundred marketing centres and their hinterlands. The relevance of these hinterlands to numbers of retail outlets and volume of trade has been demonstrated quite conclusively, and, while no definite conclusions have emerged about the extent to which cinemas serve these hinterlands, they suggest that the differential between cinema attendances in town and country may not be so very great, after all.

Apart from the suggestion which the proposer of this vote of thanks has also put, that the authors might care to speculate about the reasons for the somewhat odd seasonal pattern of attendances mentioned on p. 149, I now come to the effect of television. This is something of major topical controversy and it seems a great pity that the authors have not made fuller use of their opportunity to shed light on it. Without much more information than they have given, it can hardly be said that the relevant section in the paper contributes to the problem at all. For instance we are told that a random sample of towns in the Sutton Coldfield and Holme Moss transmitter coverage areas was selected for comparison with a sample of towns not served by any television transmitter; but might I ask what process of sampling was used? How were the sample units selected? I feel somewhat suspicious of a sample consisting of Worcester, Coventry, Nuneaton, Leicester, Derby and Nottingham which purports to be a random sample of the area covered by the Sutton Coldfield transmitter. Moreover, we are told that the picture by towns is of less interest than the overall picture. Fellows of this Society are hardly likely to be flattered by this assessment of their interest in the fundamental statistical concept of variance. I should say that the picture by towns was extremely important, and I would go further and ask for the picture by individual cinemas. And why, incidentally, was no mention made of the Alexandra Palace coverage area

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

in this analysis? Here also the density of television sets between 1950 and 1952 increased almost as markedly as in the Sutton Coldfield area.

Mr. Wilkins has already mentioned what he felt to be an inadequacy in the method of analysis of the data, using the moving average. Admittedly, the data really warrant no more sophisticated treatment, but if more material subsequently becomes available, I sincerely hope that a more adequate approach to it will be used—one which does not sacrifice quite so much of the information.

The conclusions in this section of the paper are, however, probably fairly near the truth. Several times it has been found from sample surveys that persons from homes where television is new go to the cinema only about two-thirds as often as other people in similar financial circumstances without television, and it has also been found that the frequency of attendance of those who have been viewers longer, say two years or so, is intermediate between that of the new viewers and those without television. One might speculate that as the honeymoon feeling wears off viewers return to their pre-television level of cinema attendance. The worst of this kind of survey is that one can never be sure that persons with television used to go to the cinema as often as the rest of the community before they had their television. These speculations do, however, correspond to a large degree with the matter presented in this paper.

The weakness of choosing only the Holme Moss and Sutton Coldfield areas is that television was new in those areas. In the older television areas, there would have been a body of veteran viewers, and from there a more realistic appraisal of the effect of television on cinema attendance might have been derived. I hope that the authors may be persuaded to do a further analysis of more up-to-date material in the near future and to make a fairly comprehensive analysis to validate the conclusions, which I think we are all agreed are probably correct.

Finally one more request. In the admirable sections dealing with the structure of the cinema industry, the data are generally very complete. In only one respect are we restricted—I think rather severely—and that is where the mean price of admission is given with no idea of the distribution of admission prices from which this mean arises. Could we, perhaps be given the frequency distribution of admissions by price of seat?

I have very great pleasure in seconding the vote of thanks to the authors for their paper.

The vote of thanks was put to the meeting and carried unanimously.

Miss P. M. Nye associated herself with the earlier speakers in congratulating Mr. Browning and Mr. Sorrell on their paper.

She stressed the welcome contribution made by this series of enquiries to the estimates of consumers' expenditure with which she was concerned. Before the Board of Trade had begun to collect these statistics, consumers' expenditure on the cinema had been estimated from an analysis of tax receipts by H. M. Customs and Excise in the way referred to at the beginning of the paper. Broadly, the method had been to determine the ratio of gross takings to duty paid for all taxed admissions in one week of each quarter, and then to use that ratio to gross up the tax receipts over the whole quarter. This calculation had given estimates of expenditure by cinema-goers on taxable admissions comparable with the figures shown in Table 2. The disadvantage of the method had been that tax-free admissions were ignored and, to allow for these, it had been necessary to make a guess. On comparing the figures in Tables 1 and 2, it would be found that, in 1952, tax-free admission accounted for 8 per cent. of all admissions and about £3½ million of gross takings. That was a small but appreciable part of the total, so that it was a real advance to have a regular series of figures which covered virtually the whole of that field of expenditure.

Miss Nye's second point was concerned with the average price of admission. In one of the United Nations Statistical Papers, *Retail Price Comparisons for International Salary Determination*, a figure of 6*s*. was quoted for the average price paid by a United Nations employee for a cinema admission in London in 1950. No doubt that applied mainly to cinemas in the West End, but, even so, it was interesting to note that it was about three times the average price for the County of London and nearly four times the average for the whole of Great Britain.

Finally, Miss Nye referred to two points connected with the cinema-going habit. In a survey taken in 1951, the results of which were not yet available to the general public, the Social Survey had found that the average number of attendances per month was slightly higher for men than for women, a result which bore out the findings of the Hulton Readership Survey. On the more general subject of cinema attendance, the writer of an article on "The Plight of the News Theatres" in the *Financial Times* on January 6th, said that between the end of 1951 and the end of 1953 attendances at news theatres had dropped by 25 per cent. This he attributed entirely to the influence of television.

Mr. Mason stressed the commercial use of Table 6, and wished such information could be published regularly, since much of it impinged obliquely on purchasing power changes; so, too,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the tables regarding sales of ice-cream, etc. The population bases should be more closely studied; information was needed on how far away from cinemas people lived. This was a very important factor in regard to the general trend in cinema-going. He felt more optimistic than many for this reason, that the number and siting of cinemas remained roughly the same as in 1938, but during the intervening period vast changes in total population and in the location of that population relative to the cinemas had taken place. New estates had grown up, from which the cinema might be four or five miles away. Before the war, that situation had rapidly adjusted itself, because wherever there was a nucleus of ten to twenty thousand people some entrepreneur would build a cinema, and total attendances would increase. Once the initial stages of television fever were over, there might be a return to the cinemas, if only they showed enterprise, could scrape up the funds for the erection of new cinemas, or convert existing ones to take in the larger populations.

The importance of the distribution of price-ranges had been stressed by other speakers; differences between regions were quite distinctive and might be related to other aspects of the social structure. Details regarding the day of the week, and the time of day, would also be valuable. A simple broad field survey might produce such data.

Costs had been compared "per seat" in connection with wages. He felt that more analysis was necessary, in terms of seating. It would be interesting to see how the average wage attendances varied with the number of performances.

In complimenting the authors on their work he urged that any additional information should be released, such as the Social Survey's study to which allusion had been made, as it would surely be commercially useful.

Mr. LAMBERTH also contributed to the discussion but subsequently withdrew his remarks from publication.

Mr. BROWNING expressed his appreciation of the favourable reception accorded to his paper. The criticisms which had been made were somewhat far-reaching and he would like to consider them at greater length than was possible during the meeting. He would, however, reply immediately to one or two questions.

Firstly, Mr. Wilkins had asked whether attendances in the general tables included Sunday attendances and those at children's performances. Where not otherwise stated, "attendances" meant all attendances, on any day and at any kind of performance, at the cinemas in question.

Mr. Lamberth had asked whether there was any possibility of breaking down the figures into some periods finer than quarters. Mr. Browning could not hold out any hope in that direction, and gave a warning against using other series, e.g., figures of Entertainment Duty, as the basis for interpolation.

The authors subsequently replied in writing as follows:

We are not surprised that both Mr. Wilkins and Mr. Emmett seized upon our analysis of the effects of television for the main part of their comment; nor that they did not find it a final and conclusive answer to this very difficult problem. We do not pretend that it is, but we feel that the analysis was as much as the nature of the information available to us would bear and that it was sufficient to bear the broad conclusions we drew from it: we are gratified that they both agreed that our conclusion was reasonable. On one general point we would take issue rather strongly with the proposer. He takes us to task for attempting the analysis at all, in view of the nature of the data available. We doubt whether many statisticians working in the field of economics, either in industry or in Government departments, would agree that they should not attempt the solution of their problem unless they can get "just sufficient data to solve them with precision". Leaving aside the definition of precision, we wonder, for example, what progress would have been made in developing the national income estimates if the statisticians at the Central Statistical Office had adopted this perfectionist approach. This is not to say that answers derived from imperfect data are not often subject to large margins of error and that the warnings that usually accompany them are not often ignored—even by other statisticians—but a great deal of useful work would not be done if statisticians waited until they had an adequate supply of straw to make their bricks.

On Mr. Wilkins's more specific criticism we agree that the moving average technique is far from perfect, but we find it a little inconsistent that he should want us to subject the data, which he feels are in any case unsuitable, to more refined treatment. We cannot agree that we were not justified in starting the analysis with a seasonally high and ending it with a seasonally low quarter. If there were dips at the ends of the trends of our series this was because the last quarter's figures were *more* than seasonally low and the appearances of the trends are, therefore, not deceptive but justified. Mr. Wilkins's recommended method of least squares would have given disproportionate weight to the extremes of the curves, which again seems inconsistent with his criticism.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

With Mr. Emmett's criticism of the towns we chose for the analysis we have some sympathy. They are not all that they might have been but the process of extracting the information from our records was an extremely lengthy one and we were obliged therefore to omit the really large towns (e.g., Birmingham, Manchester and Liverpool) and select somewhat smaller towns spread as widely as possible. Need to economize effort was the main reason for omitting the Alexandra Palace area. We thought it best in the circumstances to follow from the start the experience of those areas newly subject to the impact of television. On the other hand we did not select very small towns because the results might then have been significantly affected by the influx into the towns of people living in the surrounding countryside. The possible effect of these hinterlands on cinema attendances is emphasized by Mr. Emmett, but it seems likely that in a fairly large town, with over 100,000 inhabitants, an overwhelming proportion of attendances is accounted for by inhabitants of the town. We ourselves drew attention to the influence of these hinterlands but we are of the opinion that the effect would not be large enough to invalidate the general conclusions to be drawn from Table 6.

Turning now to some of the other points raised, Mr. Wilkins doubts whether the higher average price paid on Sundays is due to cinemas being fuller. We think, however, that this is an important reason as it is normally the cheaper parts of the cinema that are full first; many people who would take cheaper seats if they were available are prepared, if necessary, to take more expensive seats. It is also due, no doubt, to the fact that a larger proportion of the large and expensive cinemas, particularly in towns, are open on Sundays.

Mr. Wilkins's criticism that the response rate was not the 99 per cent. that we claimed is due to a misunderstanding. The figure of 99 per cent. relates to the number of cinemas responding to the quarterly enquiries and is true of all the enquiries the results of which were used in our paper. Table 18, as stated in the text, is an analysis, from quota returns, of cinemas covered by the enquiries, that had a six-day programme. The sales excluded from Table 24 are those by some smaller cinemas that did not reply to the question relating to sales of ice cream, etc. These cinemas did, however, make returns for the quarter which were complete in all other respects.

Mr. Emmett asks about the nature of the quarterly enquiry, but there is very little to add to the description given in the second paragraph of the paper. Certain standard questions are asked regularly each quarter (admissions, takings, duty paid, employment) and in most quarters some other aspect is covered, such as Sunday and children's admissions, wages and salaries paid, numbers of admissions at each price, etc. The results of the enquiries into the last mentioned were not dealt with in this paper, which was already over-long. Tables giving a summary of the results will be found in the issues of the *Board of Trade Journal* dated September 1st, 1951, March 8th, 1952, and September 12th, 1953.

Both the proposer and seconder ask about what they regard as the rather odd seasonal pattern in cinema admissions. We have referred in the paper to the very significant effect of summer holidays. But for this, all that would have to be explained would be the low fourth quarter and the high first quarter. Need we look further here than the effect of Christmas on spending habits in the autumn and the natural tendency to seek indoor entertainment in the coldest months of the year?

Finally, a general criticism was that too little attention had been given to the cinema audience and too much to the finance of cinemas. The main object in presenting the paper was, however, to amplify the results of enquiries already summarized in the *Board of Trade Journal*. These enquiries were naturally concerned with the economics of the industry and not with the habits of the public. Information on the latter was brought together from published sources as far as seemed desirable to illustrate and explain the data at our disposal. We agree that many aspects of the public use of the cinema remain obscure but it seems likely that these can best be investigated by enquiries of the Social Survey type rather than through questionnaires addressed to cinema managers. We hope that the questions which have been raised will stimulate others to fill in the gaps in the information which we have inevitably had to ignore.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Sunill Kumar Basu.
Karol Jozef Krotki.
Leslie Stead Cockerham.
Philip Charles Newman.
John Denys Gribbin.
Shamsher Singh.
Richard Herbert Kastell.
Bryce Harry Knox.
Ronald Bullock.
Avadh Behari Misra.
Richard William Fryer.
John Robert Scarr.
Antony Neville James.
Thomas Judge West.
Barbara Bregman.
John Noel Lauria.
Roger Dickinson.
John Eric Cutlaw.
Gareth Horsnell.
Pamela Mary Wale.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Demand for Motor-Cars in the United States

By M. J. Farrell

[Read before the Royal Statistical Society, Wednesday, February 24th, 1954, Mr. E. C. Fieller, Vice-President in the Chair]

Introduction

This paper* consists of an analysis of the demand for motor-cars in the United States, and is intended to serve as an exploration of the problems of analysing the demand for durable consumption goods, of which the motor-car is an important example. First, a theoretical model is developed which regards the market for cars as a set of inter-related markets for close substitutes. Some of the parameters in the model are estimated from cross-section data for 1941, and then the remaining parameters are estimated by a regression analysis of time-series for the period 1922–41 inclusive. Finally, the model is used to predict equilibrium prices for new and used cars for each of the years 1947–52.

1.1. *The Problems of Consumers' Durables*

The distinguishing characteristic of a durable commodity is that utility is derived from owning it rather than from consuming it. This has sometimes been expressed by saying that it is its services that are consumed. In the pure theory of consumers' behaviour durable goods have been fitted into the general analysis by regarding their "consumption" during a given period as equal to their depreciation during that period. This is quite accurate theoretically, but it leaves the paradox that so far as the industry manufacturing this commodity is concerned demand is not the depreciation on existing units, but the number of new units purchased. Of course, in a "stationary state", where the same number of units were purchased each year, the two amounts would be equal. But if there is an increase in demand manifesting itself in the addition of a certain number of units to those in use, the change in "consumption" will only be the depreciation on those extra units, while the change in demand will be their purchase price.

Expenditure on consumers' durables thus has much in common with investment; and perhaps the best procedure in theoretical work is to regard it as such. In demand analysis the point to note is that the fundamental demand is for the *ownership* of, say, cars; and that the demand for new cars is derived from this demand, being the difference between the desired and the actual number of cars in use. Thus, there will be a demand for a new car if (*a*) a family that does not own a car decides to own one in future or (*b*) a family decides to scrap its car and replace it. The third type of transaction (*c*) in which a family sells one car and buys another, is merely a transfer and does not itself produce a demand for a new car.

1.2. *Previous Analyses of the Demand for Cars*

This argument was the basis of the demand functions developed by earlier writers, for example,

* The work for this paper was done over the past four years while I was at the Department of Applied Economics, Cambridge, and travelling in America on a Commonwealth Fund Fellowship. I am grateful for the helpful discussions I have had with many colleagues on both sides of the Atlantic, especially J. R. N. Stone, T. C. Koopmans, H. S. Houthakker and R. E. Brumberg, but to no-one so much as to James Tobin. He it was who suggested the problem to me and who made that very fertile suggestion of a random distribution of tastes, and almost every stage of the investigation has benefited from his helpful comments. The very extensive calculations involved were done at the Department of Applied Economics, and I should like to thank Mrs. E. M. Chambers and Mr. R. A. Arnold for their help in this respect, and Mr. Arnold also for his help in preparing the various graphs.

I wish to thank the National Used Car Market Report Incorporated for access to their privately circulated Red Books, without which the analysis would have been impossible, and to thank C. F. Roos and the U.S. Department of Agriculture for making unpublished figures available to me.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

de Wolff (1938) and Roos and von Szeliski (1939). The latter divided demand into two parts, "new owner sales", corresponding to (*a*), and "replacement sales", corresponding to (*b*). To determine new owner sales, they first developed a function relating the demand for ownership of cars to incomes, new car prices, the expected life of cars, the "trade-in ratio" and various taste and trend factors. They then subtracted the actual stock of cars from this estimate of the desired stock, and postulated that new owner sales should depend on this difference, and also on incomes, new car prices, the trade-in ratio and tastes. Replacement sales were to be determined primarily by "expected scrappage ratio" (calculated by a system of "mortality tables"), but were also to be influenced by incomes, new car prices, the trade-in ratio, and tastes. New owner sales and replacement sales were then added to give demand for new cars.

Something should be said about the "trade-in ratio". A car is said to be traded-in when it is accepted by the dealer in part-payment for a new (or, at least, newer) car. The trade-in ratio for a given transaction is then the ratio of such part-payment to the total price; and the variable used by Roos and von Szeliski is the average of such ratios for a number of dealers from whom they were able to obtain this information. It will be seen that the product of the new car price and the trade-in ratio gives an index of used car prices, and it was to this end that the variable was included. Unfortunately, it is an index which is likely to be affected at least as much by variations in its weights (i.e., in the number of cars of different ages traded-in) as by variations in prices. In view of this, and of the small number of degrees of freedom, it is not surprising that Roos and von Szeliski found that it had no significant effect on demand, and excluded it from their final demand function. Leaving on one side such practical problems, it might be said that this was a common-sense approach to the problem, and included most of the relevant factors. However, it is open to three (related) criticisms, and it will be argued that this is due to one basic over-simplification. First, it is assumed that used cars represent a homogeneous commodity, so that on the one hand, only one index of used car prices need be used, and on the other, no allowance need be made for variations in the age composition of the stock of used cars except in so far as a greater number of very old cars leads to a higher scrappage rate. Secondly, to regard used car prices as given in predicting demand for new cars is to leave the job half done: a satisfactory demand analysis must also predict used car prices. Thirdly, it is much harder than would at first appear to justify the assumption that, in some relevant sense, intermediate (or type (*c*)) transactions "cancel out". It is true that, being merely the exchange of one car for another by the family concerned, they do not represent a demand for any addition to the stock of cars. But on the other hand, although transactions of types (*a*) and (*b*) do represent demands for additional cars, they do not in themselves represent demands for *new* cars. The marginal family will probably not invest in a brand new car, but will buy a used car of some age. This used car will have been sold by a family buying a newer car, and a chain of intermediate transactions like this will lead to the family who actually buys a new car, trading-in its old car. A similar argument holds for a family scrapping its car. Thus, although the intermediate transactions will in some sense cancel out, simply because, *ex post*, demand must equal supply, it is by no means obvious that they will cancel out in any more useful sense.

These arguments all suggest that it is an over-simplication to regard the market for cars as a single market for a homogeneous commodity instead of as a set of inter-related markets for a series of close substitutes.

1.3. *Theoretical Model*

The present study starts from the assumption that the market for cars is such a set of inter-related markets. Suppose that cars can be divided into n groups, on the basis of quality and age, such that the cars within each group constitute a homogeneous commodity. Then for each group there is a demand function, relating demand (X_i) for ownership of car of that group to incomes* (represented by the vector $\mathbf{y}$) the vector $\mathbf{p}$ of prices of cars of the different groups, and various taste factors (which may be represented by the vector $\mathbf{t}$) thus:

$$X_i = f_i(\mathbf{y}, \mathbf{P}, \mathbf{t}) \qquad (i = 1, \ldots, n) \qquad (1)$$

* Just what income variables are relevant is left open for the moment. These (and the other variables) will be defined more specifically below.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Similarly, there are n supply functions

$$X_i = \varphi_i(\mathbf{y}, \mathbf{P}, \tau) \qquad (i = 1, \ldots, n) \qquad (2)$$

where the vector τ represents other variables relevant to the supply of cars.

The $2n$ equations (1) and (2) constitute the theoretical model in its most general form. Before it can be used in a statistical analysis, specific assumptions must be made about the $2n$ functions involved. These will, of course, reduce the generality of the model, but there are two further considerations to be borne in mind. On the one hand, some assumptions are more *realistic* than others; on the other hand, some are *simpler* than others, in the sense that they make the statistical analysis easier. The simplest and the most realistic assumptions are not necessarily the same and a nice balance must be maintained between simplicity and realism. The following assumptions were actually made.

Assumption A.—The n homogeneous groups are simply age-groups

This assumption was made primarily because adequate data were not available for an analysis which distinguished between qualities and makes of cars, although it also avoids certain theoretical difficulties. Apart from manufacturing imperfections, cars of the same age may be expected to differ either because they are of different makes or models, or because they have received different treatment or maintenance. While the latter effect is probably the sort of random variation which can, and indeed must, be ignored in any practical analysis, the former definitely represents a departure from realism. It is, however, probably a less serious departure in the United States, where there are relatively small differences in size and performance between cars, than in Britain.

It is further convenient to assume that the variable i represents the age in years of the cars in the ith group, and in particular that the group $i = 1$ consists of new cars. Subject to the qualifications in the last paragraph, cars made in the same year are regarded as the same in the market, so this assumption does not involve any loss in realism.

Assumption B.—For $i = 2, \ldots, n$ the supply functions are perfectly inelastic with respect to prices and incomes

In other words, the number of used cars of a given age in use is historically determined. Except for the oldest cars, this is quite plausible; a car will remain in use unless it has met with a fatal accident. However, cars may be scrapped, not because of a fatal accident but simply because they are very old, and these present a problem. In practice, of course, there will be some such cars in a number of the older age-groups, but by virtue of assumption A, they may be localized in the last age-group, which is assumed to be the nth. The supply curve of n year old cars consists of two parts: a perfectly elastic section at a price equal to the scrap value of the cars, and a perfectly inelastic section at a quantity equal to the number of cars still in existence. If the demand function cuts the latter section, assumption B holds as for the other ages, but if it cuts the perfectly elastic section, n year old cars are freely available at their scrap price, and the assumption is false.

The importance of the assumption lies in the fact that it renders $n - 1$ of the n supply equations trivial. Thus, leaving aside the supply function of new cars, the system collapses to the n equations (1), in which $X_2, \ldots, X_n$ may be regarded as given. If $\mathbf{y}$ and $\mathbf{t}$ are also known, the system is one of n equations relating the $n + 1$ variables $P_1, \ldots, P_n, X_1$. If $n - 1$ equations are used to eliminate $P_2, \ldots, P_n$, one equation will remain, relating P_1 and X_1; this is the demand function for new cars, and will, of course, involve $X_2, \ldots, X_n$ as well as $\mathbf{y}$ and $\mathbf{t}$. The system will also determine $P_2, \ldots, P_n$ in terms of X_1 or $P_1, X_2, \ldots, X_n$, $\mathbf{y}$ and $\mathbf{t}$ again being given.

In making assumptions about the form of the demand functions it is necessary to consider the individual demand functions, that is, to consider the factors that determine whether or not an individual will own a car of a given age. It is usual in such cases to work in terms of indifference maps, but this form of analysis is particularly tedious when indivisible commodities are involved, or when situations involving zero consumption of some commodities have to be considered. In the present study, all the principal commodities are indivisible, and consumption by any individual of most of them will be zero! Accordingly, a modified form of utility analysis has been adopted, with, it is believed, no other important effect than a gain in clarity.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Assumption C.—No individual owns more than one car

The word "individual" is used in the economic, not the physical sense. It does not necessarily mean a single person, but whatever group of people can be regarded as an entity for economic purposes—a household, a family, or a spending unit. Bearing this in mind, it is clear that, particularly in the United States, individuals often do own more than one car. The assumption considerably simplifies the theoretical model, but is not essential to it. As, however, the data were not adequate to utilize the more general theory, it was decided not to complicate the exposition unnecessarily.

Write U_{ik} for the highest price at which the kth individual would purchase an i year old car, if no other car were available to him*; it will, of course, be a function of his income and tastes. He will own an i year old car if

$$\left.\begin{aligned} &U_{ik} - P_i \geqslant 0 \\ &U_{ik} - P_i \geqslant U_{jk} - P_j \qquad (j = 1, \ \ldots \ , n) \end{aligned}\right\} \quad \ldots \quad (3)$$

Assumption D.—For all k, $U_{ik} > U_{i+1,\,k} \qquad (i = 1, \ \ldots \ , n-1)$

Assumption E.—For all i, k, U_{ik} may be written $U_i(\eta_k)$ where $\eta_k = u_k y_k$ is a continuous variable. y_k being the income of the kth individual and u_k a constant to represent his tastes (in the most general sense)

D is a very harmless assumption, saying no more than that any individual will value a newer car more highly than an older one. E, however, is a crucial one. It states that the parts of their indifference maps relevant to car-ownership are the same for all individuals except for a variable u, which has different values for different individuals. Further, that the effect of this variable u on an individual's behaviour is equivalent to multiplying his income by a factor u. Finally, that given any two individuals, a third individual can always be found whose car-owning behaviour is intermediate between their's. This would, strictly, imply an infinite population, but the population of the United States is large enough for the assumption to be valid for all practical purposes. It is, of course, a quite arbitrary assumption, and was made because it leads to striking simplifications in the aggregate demand functions. It is worth pointing out that some assumption must be made about differences between individual indifference maps, that it is difficult to see how such an assumption can be anything but arbitrary, and that the present assumption allows more "difference" between individuals than the usual implicit assumption that the individual demand functions differ by additive constants.

Assumption F.—For all relevant values of η,

$$\frac{\partial U_i}{\partial \eta} > 0 \qquad (i = 1, \ \ldots \ , n).$$

Assumption G.—For all relevant values of η,

$$\frac{\partial}{\partial \eta}(U_i - U_j) > 0 \qquad (j = i+1, \ \ldots \ , n; \ i = 1, \ \ldots \ , n-1)$$

Of these two assumptions, the former, that the value attached to any given car increases with η, is highly plausible, and the latter, that the difference in the values attached to two given cars also increases with η, is not implausible and is very useful. Consider the set of demand functions (1), in a situation where incomes, tastes and the supply of each group of cars are known. The n prices must equate demand to the predetermined supply of each of the n groups of cars. Suppose that, for the marginal individual who is indifferent as to whether he owns an i year old or an $i+1$ year old car, $\eta = \eta_1$ and that at the margin between $i+1$ and $i+2$ year old cars, $\eta = \eta_2$. The marginal individuals will be indifferent because η is assumed continuous.

It can be seen that equilibrium will be reached with the X_1 individuals with the highest η's owning new cars, the next highest X_2 individuals owning two-year-olds, and so on. In particular, $\eta_1 > \eta_2$.

Also

* This is simply a device for obtaining a measure of the utility of an i year old car to the kth individual.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$\left.\begin{aligned} U_i(\eta_1) - U_{i+1}(\eta_1) &= P_i - P_{i+1} \\ U_{i+1}(\eta_2) - U_{i+2}(\eta_2) &= P_{i+1} - P_{i+2} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (4)$$

From G,

$$U_{i+1}(\eta_1) - U_{i+2}(\eta_1) > U_{i+1}(\eta_2) - U_{i+2}(\eta_2)$$

so that

$$U_i(\eta_1) - U_{i+2}(\eta_1) > P_i - P_{i+2}.$$

Thus there are equalities at the margins between "neighbouring" age-groups, and inequalities at the other margins. This means that a small change in, say, P_{i+2} will not *directly* affect the demand for i year old cars. It will, instead, affect it indirectly, by affecting the demand for $i + 1$-year-old cars and thus P_{i+1}. The same will be true for large changes, if they are thought of as composed of a succession of sufficiently small changes. Thus a man may in fact jump from owning an i year old to an $i + 2$ year-old-car, but only because the price change was too rapid for him to adjust to the intermediate equilibrium position, through which he should have passed, of owning an $i + 1$-year-old car. It follows that only P_{i-1}, P_i, and P_{i+1} are directly relevant to the demand for i year old cars. Remembering that only differences of prices occur in the above analysis the equations (1) can be written

$$X_i = f_i(\mathbf{y}, \mathbf{t}, p_{i-1}, p_i) \qquad (i = 1, \ . \ . \ . \ , n) \quad . \quad . \quad . \quad . \quad (5)$$

where

$$p_j = P_j - P_{j+1} \qquad (j = 1, \ . \ . \ . \ , n - 1).$$

$$p_n = P_n.$$

This is an important simplification of the demand functions, and is due primarily to assumptions E, F and G. It must be emphasized that at no stage is it implied that an individual does not regard all ages of cars as possible substitutes for his present car, it is the working of the market that ensures that the only substitutions he makes are of cars from neighbouring age-groups. In fact, this is much more a characteristic of the distribution of preferences over the population than of the individual indifference maps, for instance, the innocent-looking continuity assumption is crucial.

If the difficulties in analysing the demand for cars arise from their durability, there is consolation to be derived from the fact that they are also indivisible. Economists have in the past regarded indivisibility as a nuisance which spoiled the elegance of their indifference curve analysis, but it will be argued that it provides one of the rare possibilities for *a priori* knowledge to ease the burden of the demand analyst. Houthakker (1952) has shown that even highly restrictive assumptions about indifference maps cannot yield useful knowledge of the shape of the individual demand functions. In the case of indivisible commodities, it is at least known that the individual demand functions must be step functions, an individual can only own an integral number of, say, cars. If this number is large, the step function can be as complex as any continuous function, but with commodities like motor cars, for which the number is usually very small, this knowledge is by no means trivial. In this model, it is assumed that no individual owns more than one car, but it is possible to extend the analysis to cover the possibility of a family's owning two or more.*

From the analysis leading up to equations (5) it can be seen that an individual's income-demand curve for ownership of an i year old car is of the form shown in Fig. 1. If his income is less than OA he will own an older car, if it is greater than OB a newer one; only if his income lies between OA and OB will he own an i year old. Of course, the magnitudes of OA and OB will depend on prices and on u; and since they depend on u, they will vary from individual to individual. To be precise, they are given by

$$\left.\begin{aligned} U_i(uy_1) - U_{i+1}(uy_1) &= p_i \\ U_{i-1}(uy_2) - U_i(uy_2) &= p_{i-1} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

* The theory could, for instance, allow each family to own two cars by setting up separate demand functions for "first cars" and "second cars". The "first car" of a family would be defined, as, say, the newer of the two. These functions would be fitted separately to the cross-section data, and then added to give the aggregate demand functions for cars. Similarly, the analysis could be extended to any number of cars, at least in principle.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

where $OA = y_1$, $OB = y_2$. These equations may be re-written to give y_1 and y_2 explicitly, thus

$$\left.\begin{aligned} y_1 &= \frac{1}{u} G_i(p_i) \\ y_2 &= \frac{1}{u} G_{i-1}(p_{i-1}) \end{aligned}\right\} \quad \ldots\ldots\ldots \quad (7)$$

The aggregate demand functions (5) are built up by adding together all the individual demand functions like that in Fig. 1. In order to perform this operation, it is necessary to make assumptions about the distribution of y and u in the population.

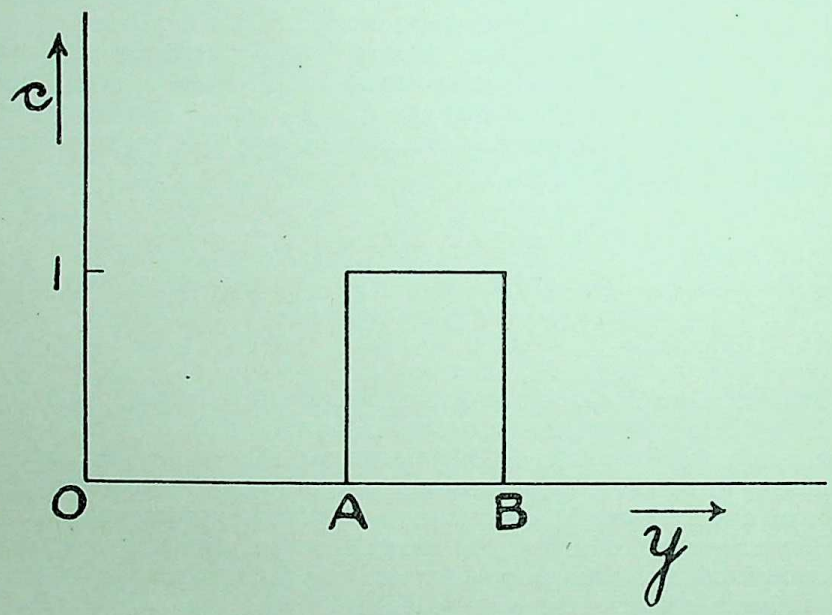


FIG. 1.

Assumption H.—The distribution of individual incomes is uniquely determined by the national or community income Y, and may be represented by the frequency function $F(Y, y)$

This is the assumption usually made in deriving aggregate from individual demand functions. It precludes any effects of redistribution of income on demand except in so far as this redistribution is correlated with changes in Y. Apart from the extreme difficulty of allowing for redistributional effects in empirical studies, what empirical evidence there is suggests that these effects are smaller than is usually supposed.

*Assumption I.**—u is a random variable, distributed independently of y with frequency function $f(u)$

The tastes represented by u include many factors, like the family's size, geographical location, social class and educational background, that might not normally be implied by the word "tastes". It is unlikely that in practice they will be strictly independent of income, but the assumption may well be a good approximation to real life.

Using assumptions H and I, and equations (7), the demand functions (5) may be re-written

* This assumption, one of the most fruitful in the paper, was suggested to me in 1949 by James Tobin. It had previously been used by Malmquist (1948), in another context, and indeed, the assumption itself was made by Allen and Bowley (1935), although, since they only applied it to linear individual demand functions, they missed its many interesting implications. A more general analysis of these implications is given in Farrell (1954).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$X_i = \int_0^{\infty} F(Y, y)\, dy \int_{\frac{1}{y}G_i(P_i)}^{\frac{1}{y}G_{i-1}(P_{i-1})} f(u)\, du \qquad (i = 1, \ldots, n) \quad . \quad . \quad (8)$$

1.4. *General Problems of the Application of the Model*

The set of demand functions in (8) is completely specified except for the form of the functions $F(Y, y)$, $f(u)$ and $G_i(p_i)$. The specification of the form of these functions can in principle be separated from the statistical estimation of their parameters, but in practice it is not wise to allow theory to run too far ahead of observation. The two problems will, therefore, be considered together at a later stage. The reader will have noticed, however, that the equations (8) are of a rather unusual form, apparently ill-adapted to the usual methods of regression analysis, so at this stage he may welcome an outline of the methods to be used in determining the functions mentioned above.

First, the equations (8) may be re-written

$$x_i = \int_0^{\infty} F(Y, y)\, dy \int_{\frac{1}{y}G_i(P_i)}^{\infty} f(u)\, du \qquad (i = 1, \ldots, n) \quad . \quad . \quad (9)$$

where $x_i = \sum_{j=1}^{i} X_j$. Next information from cross-section (or "budget") studies is used to estimate $f(u)$. Tobin (1950) showed how useful cross-section information can be in eking out time-series data, which are, for a variety of well-known reasons, almost inevitably quite inadequate. Cross-section studies in this case confer a double benefit, for, by providing a separate estimate of $f(u)$, they permit a difficult estimation problem to be evaded. $F(Y, y)$, which concerns the distribution of income only, is also estimated separately. These estimates are then treated as though known for certain, in a set of time-series regression analyses which determine $G_i(p_i)$.

This procedure does not yield maximum likelihood estimates. These could be obtained if all the error variances were known and would involve estimating all the parameters simultaneously. This was not done because of obvious manipulative difficulties, but the loss in efficiency is not likely to be serious as cross-section information is usually very much more accurate than that from time series.

Application to Cross-Section Data

2.1. *Budget Functions*

Cross-section studies give information of the following sort. A sample of families is interviewed, and each family is asked about its composition, its income and its consumption. Before publication of the study the families are almost always grouped according to income, and for each group there is given a figure for the average income of the families in that group and figures for average consumption of various commodities. This relation between average consumption and average income will be called the "budget function" for the commodity in question; it is not in general the same as an individual demand function.* In the case of cars, the budget function relates the proportion (Q_i) of the families in the group owning i year old cars to the average income of the group. Before this information can be used to estimate $f(u)$, a budget function must be derived corresponding to the assumptions made in section 1.3.

This is derived, in the same way as the aggregate demand functions (8), by adding together all the individual demand functions like that in Fig. 1. This gives the budget functions

$$Q_i = \int_{\frac{1}{y}G_i(P_i)}^{\frac{1}{y}G_{i-1}(P_{i-1})} f(u)\, du \qquad (i = 1, \ldots, n) \quad . \quad . \quad . \quad (10)$$

As before, these may be rewritten

$$q_i = \int_{\frac{1}{y}G_i(P_i)}^{\infty} f(u)\, du \qquad (i = 1, \ldots, n) \quad . \quad . \quad . \quad . \quad (11)$$

* For a general treatment of the phenomena, see Farrell (1954).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

where

$$q_i = \sum_{j=1}^{i} Q_j \qquad (i = 1, \ \ldots \ , n).$$

These budget functions, like the corresponding demand functions of (9), relate to ownership of cars not more than i years old. The corresponding individual demand function is

$$\left.\begin{aligned} c = 0, \ y < \frac{1}{u} G_i(p_i) \\ = 1, \ y \geqslant \frac{1}{u} G_i(p_i) \end{aligned}\right\} \quad (i = 1, \ \ldots \ , n) \quad . \quad . \quad . \quad . \quad (12)$$

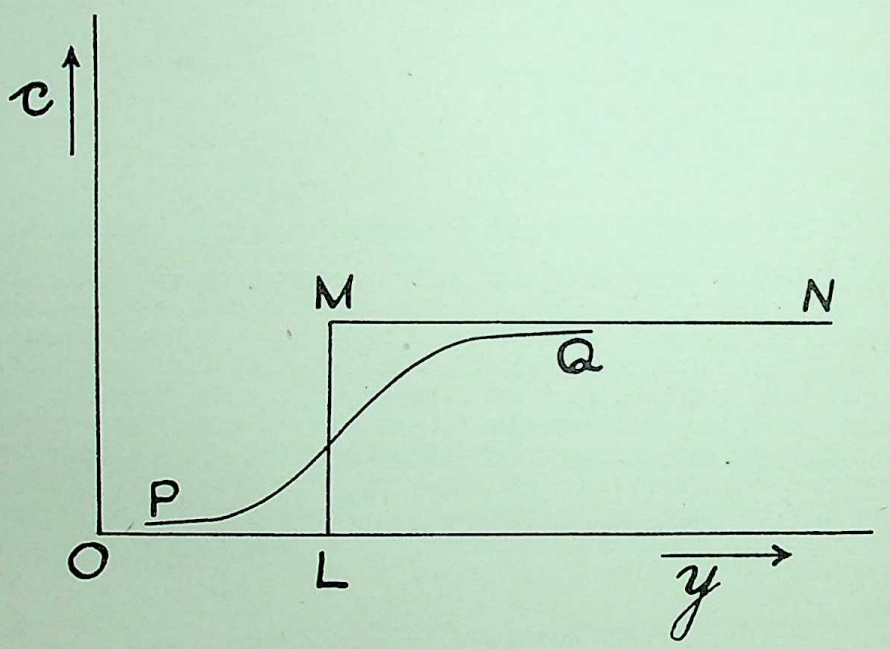


FIG. 2.

The curve *OLMN* in Fig. 2 represents a typical individual demand function. All individual demand functions will be of that form, except that the distance *OL* will vary from individual to individual—that is, will vary with u. Since the budget function is formed by adding together all these individual demand functions, its form will depend on the distribution of u in the population. Indeed, since the form of the individual demand functions is already known, the cross-section data consists simply of information about $f(u)$. If $f(u)$ is some single-humped frequency function, the budget function will be approximately represented by *PQ*. This is perhaps a good example of how different the budget function and the individual demand functions may be.

An assumption has to be made as to the form of $f(u)$, before its parameters can be estimated statistically. The central limit theorem, as well as a wealth of empirical evidence from many fields, indicates that when a variable is compounded of a large number of random variables, it is likely to be normally distributed, if the compounding consists in addition, or log-normally distributed, if the compounding consists in multiplication. These are the two most obvious assumptions to try—what sort of budget functions will they give rise to?

To fit the assumption of a normally distributed u into the theory, it would be necessary to alter assumption E so that $\eta_k = u_k + y_k$. If then U is normally distributed, the budget function becomes

$$q_i = \int_{\frac{1}{\sigma}(G_i(P_i)-y)}^{\infty} N du \qquad (i = 1, \ \ldots \ n) \quad . \quad . \quad . \quad . \quad (13)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

where

$$N = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

On the other hand, if it is assumed that log u is normally distributed (taking assumption E as it stands), the budget function is

$$q_i = \int_{\frac{1}{\sigma}(\log G_i(P_i) - \log y)}^{\infty} N\,dx \qquad (i = 1, \ldots, n) \qquad . \quad . \quad . \quad (14)$$

where $x = \log u$, $(0 < u < \infty)$.

In both cases, as $y \to \infty$, ownership tends asymptotically to the satiation level, $q_i = 1$. However, whereas in (14) as $y \to 0$, $q_i \to 0$, in (13) q_i tends to some positive constant. Clearly, in this respect (14) is more realistic. For this reason, and because it was felt that tastes and circumstances were at least as likely to be multiplicative as additive in their effect, it was decided to make

Assumption J.—Log u is normally distributed

2.2. *Estimation Procedure*

The budget functions (14) are to be fitted to observations of corresponding values of y and q_i.* Since cross-section surveys are made at a single point in time, there is no need to allow for variations in prices and tastes over time, so that $G_i(p_i)$ can be regarded as constants and written simply G_i. The parameters to be estimated are G_i and σ. Using tables of the normal integral, corresponding to each observed q_i can be determined a λ_i such that

$$q_i = \int_{\lambda_i}^{\infty} N\,dx \qquad (i = 1, \ldots, n) \qquad . \quad . \quad . \quad . \quad (15)$$

Comparing (14) and (15), the regression equations can be written

$$\lambda_i = \frac{1}{\sigma} \log G_i - \frac{1}{\sigma} \log y \qquad (i = 1, \ldots, n) \qquad . \quad . \quad . \quad (16)$$

All n equations have the common predetermined variable y, and the common parameter σ. Each equation has a unique dependent variable λ_i and a unique parameter G_i.

In so far as the error variances in the equations (16) are known *a priori* it is desirable to use this knowledge in the estimation of the parameters. Consider any observed value of q_i, and suppose it corresponds to an income group which has m members in the sample. Then q_i is an estimate of the proportion of people in the population owning a car not more than i years old, and the sampling variance of this estimate is $\frac{q_i(1 - q_i)}{m}$. The sampling variance of λ_i may be derived by considering a small change δq_i in q_i in (15). Thus

$$\delta q_i = \frac{dq_i}{d\lambda_i} \delta\lambda_i$$

$$= \left(\frac{d}{d\lambda_i} \int_{\lambda_i}^{\infty} N\,dx \right) \delta\lambda_i$$

$$= -\frac{1}{\sqrt{2\pi}} e^{-\frac{\lambda_i^2}{2}} \delta\lambda_i$$

$$(\delta q_i)^2 = \frac{1}{2\pi} e^{-\lambda_i^2} (\delta\lambda_i)^2$$

* The problem, and its solution, are similar to those met in probit analysis. Cf. Finney (1947).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Taking expectations,

$$\text{var}\,(\lambda_i) = 2\pi e^{\lambda_i^2}\,\text{var}\,(q_i)$$

$$= \frac{2\pi}{m}\, e^{\lambda_i^2} q_i(1 - q_i) \qquad . \quad . \quad . \quad . \quad . \quad (17)$$

These errors are not necessarily the only ones in equations (16), but as they are the only ones whose magnitude is known *a priori*, their variances were used as a basis for weighting the observations. To be precise, the equations (16) were fitted by weighted least squares, each observation being given a weight equal to the reciprocal of its sampling variance as shown in (17).

2.3. *Results of Cross-Section Analysis*

The principal source of cross-section information was *Family Spending and Saving in Wartime*, Bulletin 822 of the U.S. Bureau of Labor Statistics. This survey gives figures for car-ownership at the end of 1941, for a sample of 1,300 urban families. These families (or "spending units") are divided into nine income groups, and for each group is given the percentage of families owning cars of each age. These percentages were used as the basis of estimates of q_i, while figures for the average disposable money plus non-money income of families in each group gave estimates of y. The results of applying the methods of the previous section to these figures are given in Table 1. It is worth noting that G_i is equal to the income (in dollars) at which just 50 per cent.

TABLE 1

i	1	2	3	4	5	6	7	n
$\log G_i$ . .	3·877	3·756	3·650	3·584	3·474	3·392	3·361	3·236
G_i . .	7,530	5,710	4,470	3,830	2,980	2,470	2,290	1,720
σ . .	·387							

of families may be expected to own a car of not more than i years old, as can be seen from equation (14). Figs. 3–8 inclusive show the estimated budget functions (10), with the observed points to which they were fitted. The fit is quite satisfactory considering that each equation in (10) is the *difference* of two equations in (11).

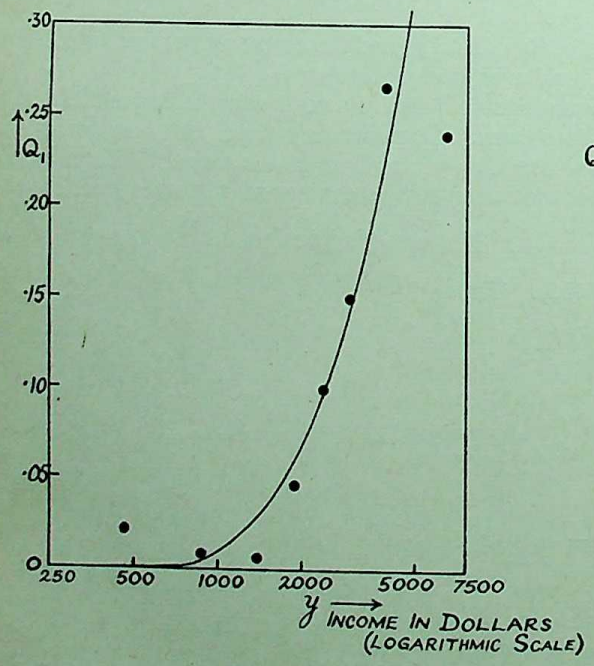


FIG. 3.

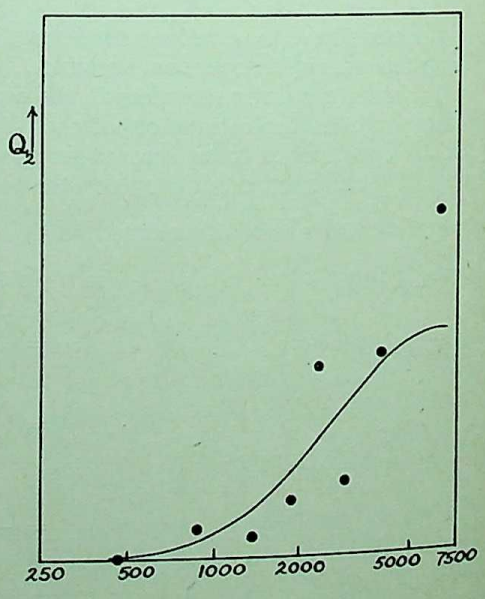


FIG. 4.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

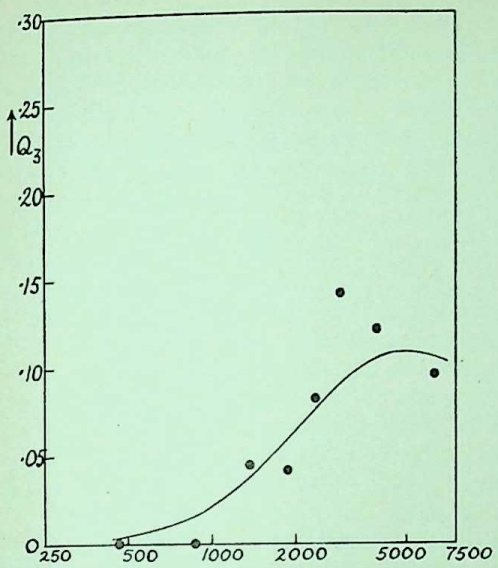


FIG. 5.

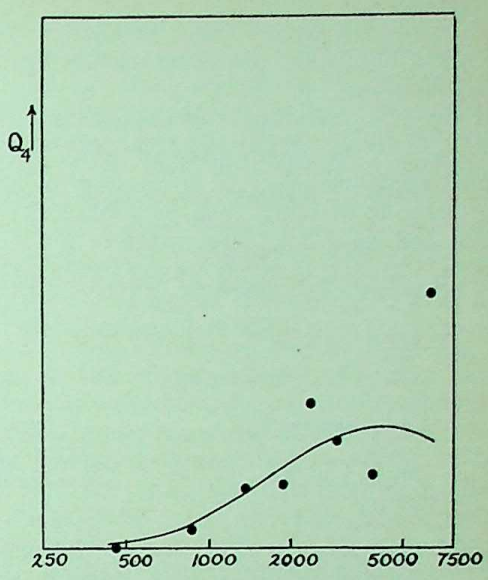
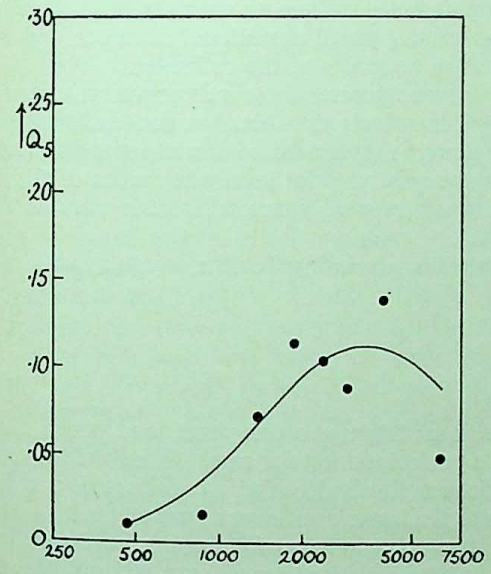


FIG. 6.



FIG, 7.

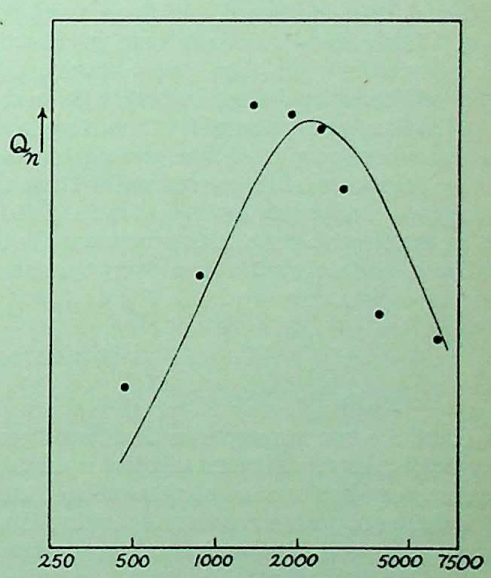


FIG. 8.

TABLE 2

i	1	2	3	4	5	6	7	n
log G_i . .	4·010	3·801	3·647	3·572	3·466	3·387	3·358	3·232
G_i . .	10,240	6,320	4,440	3,730	2,920	2,440	2,280	1,710
σ_i . .	0·503	0·436	0·383	0·366	0·364	0·354	0·361	0·433

Table 2 shows the effect of allowing a different value of σ in each of the equations (16). Except in the case of new cars, this seems to make remarkably little difference to the estimates of G_i, and values of σ_i do not vary very much. As this procedure represents a partial relaxation of assumption E, these results represent a partial vindication of that assumption.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Unfortunately, the survey's results for rural families do not include a cross-classification by income of family and age of car, so that this analysis had to be limited to urban families.

2.4. *Some Further Results of Cross-Section Analysis*

However, the figures given do permit the estimation of the relationship between income and overall car-ownership (i.e., irrespective of age of car) for rural families. That is to say, it is possible to fit that one of the equations (16) for which $i = n$. As it is of some interest to see how urban and rural families compare in this respect, these equations were fitted for the different groups. In fact, three groups are distinguished by the survey, urban, farm and rural non-farm. The same procedure was followed as in the previous section, except that only one equation was fitted in each case. The resultant estimates of G_n and σ are given in Table 3, together with the

TABLE 3

Survey		log G_n		G_n (1941 $)	R^2
1935:	Urban	$3{\cdot}101 \pm 0{\cdot}006$	$0{\cdot}436 \pm 0{\cdot}011$	1,260	0·996
	Rural non-farm	$2{\cdot}930 \pm 0{\cdot}014$	$0{\cdot}424 \pm 0{\cdot}021$	850	0·985
	Farm	$2{\cdot}724 \pm 0{\cdot}024$	$0{\cdot}428 \pm 0{\cdot}032$	530	0·933
1941:	Urban	$3{\cdot}224 \pm 0{\cdot}022$	$0{\cdot}418 \pm 0{\cdot}036$	1,675	0·964
	Rural non-farm	$2{\cdot}947 \pm 0{\cdot}035$	$0{\cdot}379 \pm 0{\cdot}051$	885	0·956
	Farm	$2{\cdot}889 \pm 0{\cdot}025$	$0{\cdot}362 \pm 0{\cdot}033$	775	0·973

corresponding results for similar data from the 1935–6 study of consumer purchases by the National Resources Planning Board. With each estimate of a parameter is given an estimate of its standard error. These standard errors were calculated by the crude "small deviations" method, and are not intended as more than a very rough guide as to the accuracy of the estimates.

It will be noticed that, in both 1935 and 1941, G_n was greater for rural non-farm than for farm families, and greater still for urban families. This reflects the fact that the less populous the area where people live, the greater, generally speaking, is their need of a car. It is also noteworthy that, even after correction for the change in the general price level, the values of G_n for each group were lower in 1935 than in 1941. This was presumably due, at least in part, to the rise in the relative price of cars between the two dates.

These results are perhaps not very spectacular; but it is reassuring that they agree so well with common-sense.

Application to Time-Series

3.1. *Theoretical Problems of the Time-Series Analysis*

There are two assumptions that have been made implicitly up to this point, and which must now be discussed. The first of these is that there is a perfect market for cars. This is clearly not the case, for when cars are bought and sold through dealers, the dealer takes a considerable margin, while there are presumably corresponding disutilities to the buyer and seller in private sales. This imperfection will lead individuals to deviate from the behaviour postulated in the theoretical model. An individual who would, theoretically, always own a four-year-old car, will not wish to incur the costs of annual sales and purchases, and instead will, perhaps, buy a three-year-old car and keep it three years before selling it. However, there would seem to be no reason why these deviations should be in any way systematic; and if they can be regarded as random and independent of the other variables involved, they will average out over the community.

The other assumption is that the price relevant to the demand equations (8) is simply the purchase price of the car. This is, of course, contrary to the usual economic theory, which states that the relevant price is the sum of depreciation, maintenance and running costs, and is related to purchase price only in so far as depreciation is related to purchase price. There is scope for a good deal of nice argument as to whether owning a car should be regarded as allocation of assets or as expenditure of income. In purest theory the two are, of course, equivalent, but realism demands that the attitude of the individual to risk and uncertainty, and the various imperfections of the capital market be taken into account. Indeed, the present study might well have made some empirical contribution to such an analysis, but for certain practical difficulties.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

First of all, it is very difficult to construct an index of maintenance and running costs. A large part of these costs consists of repairs and other services, and these depend not only on the prices of spare parts and labour, which could with difficulty be measured, but also on the efficiency and competitiveness of the industries concerned—which one can scarcely hope to measure, short of a major investigation. It is, of course, possible to measure the prices of petrol, oil and tyres, but costs vary much more as a result of variations in the consumption of these materials (and of repairs) than as a result of changes in their prices. It is worth noting that this is probably the most important respect in which cars of different ages differ, so that if the "price" of a car were defined as the sum of depreciation, maintenance and running costs, "prices" of cars of different ages would differ very much less than their purchase prices, and so the analysis would be much more sensitive to inaccuracies in the estimation of prices.

For these reasons it is impracticable to include maintenance and running costs explicitly in the analysis. Rather, differences in such costs between cars of different ages must be allowed to show up as differences in quality, and variations in running costs over time as trends of some sort. So far as depreciation is concerned, the expected depreciation on a car will be highly correlated with its purchase price, so that the present study can do little to discriminate between the two. However, the obvious measure of expected depreciation is $P_i - P_{i+1} = p_i$. Since the present study, starting from purchase price as the relevant price, has to work with first differences of prices, if first differences were taken as a measure of depreciation and hence as the relevant price, the analysis would involve *second* differences of purchase prices. It will be seen below that the price data, though they will just stand first differences, would be far too inaccurate to allow the taking of second differences.

3.2. *Practical Problems of the Time-Series Analysis*

The time-series analysis presents a number of practical problems which are caused by disparities between the actual data and the variables postulated by the theoretical model. In these circumstances there is a strong temptation to "adjust" the data—perhaps quite arbitrarily—in order to obtain "estimates" of the theoretical variables. If this is done, it is impossible to tell how far the ability of the theory to relate the variables is due to some economic law, and how much to the judgment of the "adjuster". This temptation has, therefore, been resisted as much as possible, and wherever feasible the unvarnished data have been used in computations, the disparity between theory and practice being merely noted.

Perhaps the most important of these problems concerns the division of the population into farm, rural non-farm, and urban groups. Since the *Survey of Spending and Saving in Wartime* did not provide information as to car-ownership by rural families, cross-classified by age of car and income group, the budget functions derived for ownership of cars of each age were for urban families only. On the other hand, the series of figures for the number of cars in use is for the country as a whole, and indeed includes not only all cars owned by private families, whether urban or rural, but also taxis and other cars owned for business purposes. This series thus differs from the theoretical variable in two ways, and each of these differences may cause a serious error. The series for personal disposable income is also for the whole country, although figures are available for the net income of the farm population, which would make an approximation to non-farm income possible. The population figures can similarly be broken down into farm families and others.

The question is whether the demand functions should be developed for urban families only, or for non-farm families, or for all families. The first solution would involve "adjusting" all three series, or allowing discrepancies in all three to go unadjusted. The second would involve a discrepancy only in the series for the number of cars in use, but would necessitate inferring budget functions for rural non-farm families from those for urban families. The third would still leave a discrepancy in the number-of-cars series, and would further demand inferring budget functions for farm families.

It seems plausible *a priori* to assume a simple relation between urban and rural non-farm budget functions but not between those for urban and farm groups: farmers are notoriously less concerned to have an up-to-date car. This assumption is born out in fact by the figures of Table 4,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Age of Car in Years	*Percentage Owned by*		
	Urban Families	*Rural Non-farm Families*	*Farm Families*
1	14·4	13·2	11·1
2	8·5	9·5	8·3
3	9·7	7·2	6·6
4	7·4	6·2	6·9
5	14·2	11·8	12·3
6	11·2	10·6	11·3
7	5·8	10·1	7·8
more than 7	27·7	30·5	35·0

The second and third columns are taken from unpublished data of the "Survey of Spending and Saving in Wartime", Bureau of Human Nutrition and Home Economics, U.S. Department of Agriculture.

showing the age distribution of cars owned by the various groups. The rural non-farm distribution lies closer to the urban than does the farm distribution.

The second solution was therefore adopted, as this did not involve implausible assumptions, and yet left a discrepancy only in the number of cars series, where there was in any case bound to be a discrepancy owing to the inclusion of the registrations of commercially owned cars. The specific assumption made in order to obtain budget functions for rural non-farm families was that a rural non-farm family may be expected to behave, in respect of car-ownership, in precisely the same way as an urban family with a proportionally higher income, the proportion being given by the ratio of the respective values of Y_0 in Table 3. Thus the demand functions derived are for the ownership of cars by non-farm families.

A second problem arises out of the fact that a demand function is essentially a static concept, whereas the economy behaves (not unnaturally) in a dynamic way. The demand function predicts the steady level of demand that will correspond to a given steady level of income and prices, and if in the economy these variables remained steady over sufficiently long periods, this particular problem would not arise. If, however, these variables are continually changing—as they are in practice—then with what lag should each variable appear in the demand function?

It was decided to take price and registration figures for December 31st each year, and to relate them to the average income for that year. This is a quite arbitrary assumption, but it involves no "adjustment" of the published figures; and it is not clearly less plausible than other assumptions which involve considerable "adjustment". The series of car prices may be regarded as applying quite satisfactorily to December 31st for, although they are published as prices for January or for January and February, or for the first quarter (the practice varies from year to year), the volumes in question are published early in January, so that the prices given should be closely related to the prices on December 31st. However, in the case of registrations, another problem arises. After 1933, registrations at December 31st are estimated by interpolation from figures for registrations at July 1st. This is quite satisfactory so long as new models are put on the market on January 1st, but since 1935 the new models have appeared in November. This being the case, there is no good method of estimating the number of the following year's models sold before December 31st. An "adjustment" could be made by counting all new registrations in November and December as being of the new model, but this was not done.* The omission of these cars might be thought to lead to a serious error, but it is argued that the error is considerably diminished by the expectations factor. The analysis could be performed with prices and registrations on the eve of the introduction of the new models. If this were done, the error would disappear. But on that day prices of used cars would be extensively influenced by expectations of what these prices would be in one or two months' time. Thus, we may assume that, unless the market's expectations are at fault, prices in November will be very similar to those on December 31st. Of course, if the new models proved to be of revolutionary design, the market's expectations will probably be at fault; but the theory does not pretend to cope with revolutionary changes in design.

* As an experiment, the demand function for new cars was recalculated making this adjustment, but there was no significant change in the estimates of the parameters, and R^2 was slightly reduced.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A third problem—that of how many age-groups of cars to consider—was determined by the limitations of the data. For some years no information was available about the prices of cars more than six years old. It was therefore decided to regard all cars more than five years old as constituting a homogeneous group, and to treat the prices of six-year-old cars as the prices relevant to this group. This is, of course, an approximation, but a line had to be drawn somewhere.

Similarly, the period over which the analysis was to be performed was determined by the data. On the one hand, adequate information on prices was not available before 1922; on the other hand, the war made observations after 1941 useless. The period 1922 to 1941 inclusive was therefore chosen.

3.3. *The Construction of Price-Indices for Cars*

In section 1.3 and 3.1 it was shown that the relevant price variables are the differences in price between cars of a given age and those a year older. For example, the value of P_2 at December 31st, 1941, is the difference in price between a 1940 model car and a 1939 model at that date. This is so for all groups except the oldest, for which the relevant price is simply the price of cars of that age; that is, at December 31st, 1941, the value of p_6 is simply the price of 1936 model cars.

It was decided to base the indices on the prices of the three most common "popular" cars—Ford, Chevrolet and Plymouth. In 1941 these makes accounted for about half the sales of new cars. In addition, there is no great difference in seating capacity and performance between cheap and expensive cars in the United States, the expensive cars are simply more luxurious versions of the popular cars. It proved fairly easy to identify the "standard" model of each of these makes, usually the cheapest saloon car seating at least five persons. Exceptions were made when it appeared that a more expensive car was accounting for most of the sales, for instance, in the later years of the period it was judged that the eight-cylinder rather than the six-cylinder was the "standard" Ford model.

Perhaps the most difficult problem in constructing a price-index for so highly finished a product as a car is to allow for changes in quality. Over the period 1922–41 there was obviously a vast change in the comfort and performance of the "standard" car, indeed, of any car. In addition, there were variations in durability and in the tools and accessories included in the price. In so far as these changes were spread evenly over the period, they may be regarded as a trend in the quality of cars and presumably an upward one. In principle such a trend is separable from the trend in demand that must be presumed to exist, but in practice it is most difficult to separate them, and it was decided to allow one trend term in the demand functions to cover both factors. However, many of the changes are by no means gradual, and the big jump in quality that occurs when a manufacturer introduces a revolutionary new model is very difficult to deal with. An index of price-differences is particularly sensitive to such jumps, and the wildest fluctuations may be expected. Fortunately, the manufacturer often continues to produce his older model for a year or two, and when this happens the jumps can be smoothed out quite satisfactorily. Another device was to assume that, without the new model, the price-difference would have moved proportionally to the price-difference for some other make where no new model was introduced. By such expedients relatively smooth series were obtained; but it should be emphasized that fluctuations due to quality changes were not by any means entirely eliminated and that where they were reduced the methods used involved a great many arbitrary and *ad hoc* "adjustments".

The source of the price information was the series of National Used Car Market Report Red Books. These books are dealers' guides, offering estimates of the value of used cars of each model as a basis for the dealers' transactions. The estimates, being made by experts on the basis of an extensive study of markets, must be regarded as the best available, but, like all estimates, are liable to error. They are intended to guide dealers, and the question must arise as to how far dealers are guided by them. Random deviations by individual dealers are, of course, inevitable, but there may also be systematic deviations by dealers as a group. These are particularly likely to occur when there is a sudden turn, either upwards or downwards, in the market: there seems to be nothing that can be done about them.

The estimates of price actually used are those of "Average Cash Value" ($= \frac{2}{3}$ of "Average Retail Value"). The index used is simply the arithmetic mean of the price-differences for Ford, Chevrolet and (after 1930) Plymouth "standard" models. In the case of p_1 there was an additional problem. For "new" cars—e.g., at December 31st, 1941, for 1941 model cars—there are

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

available two distinct prices, the new price and the used price. It would seem *a priori* that the former was the relevant price, as most people owning a car less than a year old have bought it new. This hypothesis was supported by the facts, the price-index based on the new price giving a much better correlation than the other.

3.4. *Notes on the Other Series Used*

(a) *The general price index* (p_0) is simply the cost-of-living index, taken from Dewhurst *et al.* (1947), p. 697, altered to 1941 = 100.

(b) *Non-farm population at July 1st* is estimated by interpolation and subtraction from series for total population at July 1st (*Historical Statistics of the United States*, series B 31) and farm population at January 1st (*Agricultural Statistics*, 1947, Table 599). This is reduced to an index with 1941 = 100 to give M, the index of population.

(c) *Non-farm personal disposable income per head.*—Personal disposable income for the whole country is taken from Dewhurst *et al.* (1947), p. 696. Net income to persons on farms from farming (*Historical Statistics of the United States*, series E 94) is adjusted by a proportionality factor to equal personal disposable income of the farm population for 1941, as given in *Survey of Spending and Saving in Wartime*, to give an estimate of personal disposable income of the farm population. The latter series is subtracted from the former, and the difference divided by the above estimate of non-farm population and expressed as an index with 1941 = 100 to give Y_t.

(d) *Number of cars in use at January 1st by age.*—Up to 1933 the figures are estimates made by C. F. Roos for his paper. Thereafter, the estimates are obtained by interpolation from the figures of R. L. Polk & Co. for July 1st, as given in *Automobile Facts and Figures* (various years). These figures are first adjusted by proportionality factors, to equal the estimates of cars of various ages owned by non-farm families in 1941 given in the survey, and then adjusted by M to reduce them to ownership by a constant population. These adjusted figures are the x_i.

3.5. *Estimation Procedure*

Having determined $f(u)$, the next step is to determine $F(Y, y)$. It had been hoped to use some simple analytic function that graduated the income distribution satisfactorily, but unfortunately no such function could be found. It was therefore decided to work from the distribution of income given by the 1941 survey, and to make the following assumption about the relation between Y and y.

Assumption K.—$\lambda F(\lambda Y, \lambda y) = F(Y, y)$

This would happen if, for instance, the incomes of all families varied proportionally, but is a much weaker assumption. Equations (9) can now be re-written

$$x_i = \int_0^\infty F_0(y)\,dy \int_{\frac{1}{\sigma}(\log G_i(P_i) - \log y - \log Y_t)}^\infty N\,du \qquad (i = 1, \ldots, n), \qquad (18)$$

where Y_t is the ratio of national income in year t to that in 1941 and $F_0(y)$ is the distribution of income given in the 1941 survey. σ and G_i, the value of $G_i(P_i)$ in 1941, have been determined in the cross-section analysis. For each observed value of x_{it} (i.e., of x_i in year t) it is possible to calculate a k_{it} such that

$$x_{it} = \int_0^\infty F_0(y)\,dy \int_{\frac{1}{\sigma}(\log G_i - \log y - \log k_{it})}^\infty N\,du \qquad (19)$$

The integration over y was in fact carried out by numerical aggregation over the lower income groups and by applying a Pareto curve to the highest (open-ended) income-group. This was done for a series of values of k_i, and k_{it} corresponding to given values of x_{it} were determined by graphical interpolation.* From (19)

* The relations between the x_i and the k_i were in fact markedly curvilinear. Had this not been so, it would have been possible to write x_{it} for k_{it} in (21), and achieve a good approximation to the demand functions with much simpler calculations. As it is, such an approximation would be a very rough one, unless the variations in the x_i were small.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5

Year	Cost of Living Index Average for Year	Indices of Differences in Car Prices at December 31st						Index of Non-farm Personal Disposal Income per Head	Estimated Numbers of Cars less than a given Age Owned by Non-farm Families at December 31st adjusted to 1941 Population					
	p_0	p_1	p_2	p_3	p_4	p_5	p_6	Y	x_1	x_2	x_3	x_4	x_5	x_6
1922	113·8	259·9	65·5	97·4	80·0	70·3	49·5	85·01	2,685	3,786	5,588	7,203	7,908	8,948
3	115·9	195·2	85·5	123·8	85·2	46·8	37·1	96·06	4,225	5,610	7,155	8,787	9,981	10,605
4	116·1	163·1	95·8	97·4	118·5	47·8	28·3	95·39	3,910	6,600	8,687	10,097	11,301	12,017
5	119·1	254·5	54·7	121·1	67·8	45·0	18·0	96·07	3,898	6,250	9,447	11,294	12,229	12,878
6	120·0	196·9	80·6	63·5	83·1	30·9	14·4	97·85	4,071	6,474	9,373	12,079	13,222	13,425
7	117·9	228·4	69·8	83·9	47·6	31·9	13·2	96·85	3,084	5,838	8,956	11,565	13,526	13,707
8	116·5	243·5	64·9	58·4	31·4	28·1	17·5	97·36	3,821	5,661	8,974	11,838	13,741	14,412
9	116·4	224·5	89·9	31·4	22·3	9·4	12·7	101·94	4,466	6,757	9,240	12,142	14,112	14,961
1930	113·5	225·4	82·9	127·0	10·1	8·4	7·6	91·21	2,900	6,001	9,059	11,284	13,423	14,660
1	103·3	226·4	81·2	80·5	52·7	30·9	0·8	78·04	2,067	40,38	7,672	10,492	12,233	14,263
2	92·7	195·8	70·7	90·3	46·6	41·2	8·4	60·40	1,196	2,748	5,065	8,647	11,034	13,813
3	87·8	108·2	101·0	101·7	98·0	79·7	55·9	57·24	1,583	2,291	4,092	6,390	9,720	14,009
4	90·9	124·5	92·0	96·0	81·0	59·4	45·2	64·83	1,941	2,882	3,884	5,632	7,679	14,341
5	93·2	111·8	57·8	101·7	11·4	53·1	55·8	68·48	2,523	3,686	5,007	5,987	7,527	14,892
6	94·2	128·9	66·8	79·1	84·5	71·9	69·2	79·22	3,481	4,935	6,614	7,918	8,695	15,821
7	97·6	151·1	57·7	73·4	81·0	53·1	65·1	82·35	3,660	5,854	7,946	9,575	10,593	16,530
8	95·8	199·8	68·6	87·6	67·6	50·0	57·2	74·86	1,776	4,460	7,326	9,334	10,670	16,138
9	94·4	160·5	68·5	93·2	74·2	59·3	70·4	79·95	2,447	3,484	6,520	9,345	11,067	16,542
1940	95·2	154·6	63·9	90·4	91·2	84·4	70·4	85·41	3,101	4,561	6,085	9,074	11,578	17,186
1	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·00	3,926	5,767	7,818	9,273	11,939	18,217

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$k_{it} = \frac{G_i \,.\, Y_t}{G_i(p_i)}$$

or

$$G_i(p_i) = G_i \,.\, \frac{Y_t}{k_{it}} \qquad (i = 1, \ \ldots \ , n) \qquad . \quad . \quad . \quad . \quad (20)$$

At this point it is necessary to make some assumption about the form of $G_i(p_i)$. In the absence of any *a priori* arguments as to its form, it was assumed to be linear, and further assumed to involve a time variable t linearly, to allow for trends of various sorts.

Strictly speaking, the most realistic model would be on which regarded $P_1, X_2, \ \ldots \ , X_n, Y$ and t as predetermined variables, and X_1 and $P_2, \ \ldots \ , P_n$ as dependent. As this is well nigh impossible to translate into the system of equation (20), perhaps the best approximation is to take the p_i as the dependent variables. This would be justified if $P_1, \ \ldots \ , P_n$ were the dependent variables in the basic model (8). This is also satisfactory in that the largest errors are probably in the p_i.

Finally, there is the problem of specifying the errors in the equations (20). Again, lacking any *a priori* guide, it was assumed that such errors were normal and independent, and entered the equations (20) additively. Thus the regression equations were

$$p_{it} = a_i + b_i \frac{Y_t}{k_{it}} + c_{it} + \varepsilon_{it} \qquad (i = 1, \ \ldots \ , n) \qquad . \quad . \quad . \quad (21)$$

These equations have been derived on the assumption of a constant population and general price level. In fact, both were subject to considerable change. To allow for changes in population, the x_{it} used in calculating k_{it} were adjusted by an index of population, and similarly Y_t was defined as an index of income per head, and not simply as an index of national income. To allow for changes in the general price level, an index p_0 of the general price level was explicitly introduced, giving

$$\frac{p_{it}}{p_{ot}} = a_i + b_i \frac{Y_t}{p_{ot} k_{it}} + c_i t + \varepsilon_{it} \qquad (i = 1, \ \ldots \ , n) \quad . \quad . \quad . \quad (22)$$

3.6. *Results of the Time-Series Analysis*

The procedure outlined in section 3.1 was applied to these series, and the results of fitting equations (22) are given in Table 6. R^2 is the square of the multiple correlation coefficient, and

TABLE 6

i	a_i	b_i	c_i	R^2	R^{12}
1	0·7257	1·02±·49	−0·045±0·014	0·37	0·66
2	0·2422	0·52±·19	—	0·26	0·67
3	0·2104	0·75±·28	—	0·28	0·73
4	−0·5298	1·52±·30	—	0·59	0·77
5	−0·2258	0·81±·25	0·021±0·007	0·61	0·80
6	−1·0166	1·20±·25	0·078±0·010	0·81	0·81

may be interpreted as the proportion of the variance of the dependent variable that has been explained by the regression. While these values are small, it should be remembered that very often in time-series regression analysis, it is R and not R^2 that is quoted—and that R can be strikingly larger than R^2. The values of R for these regressions range from 0·51 to 0·90.

R^{12} is the square of the correlation coefficient between the actual and predicted values of the P_{it}. That the values of R^{12} are so much larger than the corresponding values of R^2 indicates that there is a negative correlation between the errors in the different equations, e.g. if Σ_{it} is large, Σ_{t+it} will tend to be small. As it is the P_{it} that we are interested in, it is comforting that they are so much more practical than the P_{it}.

The figures given with the estimates of b_i and c_i are estimates of their standard error; c_2, c_3 and c_4 were omitted from their regression equations as insignificant. It is interesting that there was a negative trend in the price-premium of new cars, positive trends for $i = 5$ and 6, and no significant trend for the equations between. These differential trends represent a tendency for

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the rate of depreciation of cars to decrease with time. This may have occurred because cars have become more durable, because older cars have become relatively more acceptable to the public, or because the rate of technical improvement had diminished. The estimates of b_i, although all significant at at least the 5 per cent. level, are unsatisfactory in that there seems to be no systematic relation between b_i and i. There is, of course, no *a priori* reason why the b_i should be the same for all i, but the variations seem both large and erratic. However, the standard errors are so large that none of the b_i is significantly different from a value of, say, 0·9. There is a systematic increase in the a_i with i, except for a_1, which was too low, presumably in compensation for the unusually high b_1.

In general, these results accord very well with common sense, so that, although the smallness of the correlation coefficients and the behaviour of the b_i indicate a large error variance, there is no evidence of distortion or of the omission of important systematic factors. In view of the shortcomings of the data, discussed in sections 3.2 and 3.3, it is tempting to suggest the verdict that the model itself is satisfactory and would work very well, given accurate enough information. This, however, is pure speculation, and could only be substantiated by applying the model to such data. Moreover, although it was more or less an accident that farm families had to be excluded from the model, and it is perhaps possible in principle to separate private from business registrations, the inaccuracies in the price indices are inherent in their nature.

The final set of demand functions may be written

$$X_i = \int_0^\infty F_0(y)\,dy \int_{\frac{1}{\sigma}\log\frac{H_i}{y}}^{\frac{1}{\sigma}\log\frac{H_i-1}{y}} N\,du \qquad (i = 1, \ldots, n) \ldots \quad (23)$$

where

$$H_i = \frac{G_i}{b_i Y_t}\left(P_{it} - P_{i+1,\,t} - p_{ot}\,(a_i + c_i t)\right)$$

a_i, b_i and c_i are given in Table 6, G_i and σ in Table 1, and $F_0(y)$ is the distribution of income given in the 1941 survey.

Prediction of Post-War Demand

4.1. *Prediction and Verification: A Digression*

Little emphasis has been laid upon the multiple correlation coefficients obtained in the last section, on standard errors or on other tests of significance, because it was believed that the predictions given in the following sections would constitute a much "better" test of the theory. Many econometricians would agree that prediction affords, in some sense, a "better" test of a theory's validity than the usual tests of significance based on statistical theory. That this intuitive belief has some rational basis is suggested by the number of economic theories that achieve a very "good fit" for the years to which they are fitted, but break down badly on being used to predict only a year or two ahead.

The basic difference between econometrics and most other fields where statistical theory is applied is that the economist cannot conduct experiments in which the effects of each variable are isolated. He must apply his analysis to historical data, in which, during any particular period, some relevant variable may have remained constant, or been highly correlated with some other variable. The econometrician who applies his theory to this period will be able to obtain a good fit without including the dormant variable. Then, when he uses his model to predict, the dormant variable may spring to life and his predictions are ruined. As the economic system is so complex that many possibly relevant variables have to be excluded from any given model this may happen at any time.

It may be commented that the trouble was simply that the model was fitted to too short a period, and that had the years for which the prediction was made been included in the analysis, all would have been well. To some extent this would have been true, but the problem is more complex than that.

To make the argument more specific, consider the following problem. In period 1, x and y are related by the equation $y = a_1 + bx$, and in period 2 by the equation $y = a_2 + bx$. The difference between a_1 and a_2 is due to some dormant variable. Observations are available for both periods. What is the best way of estimating the relationship between x and y?

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

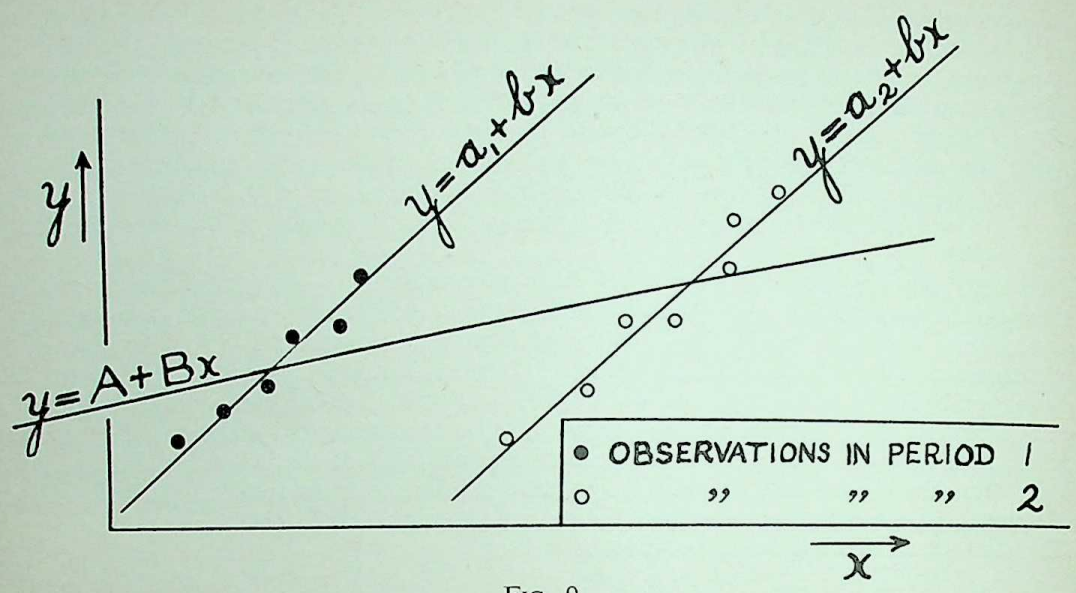


FIG. 9.

The procedure of fitting a linear function to all the data would yield a regression equation $y = A + Bx$, where $A > a_1, a_2$, and $B < b$. This is illustrated in Fig. 9. A careful scrutiny of the residuals would, of course, indicate the presence of a dormant variable. However, the same result would be achieved by fitting a regression equation to the data for period 1 and predicting y in period 2, or by predicting y in period 1 from an equation fitted to the period 2 data. The advantage of the latter method is that it discovers dormant variables automatically, and does not rely on a scrutiny of residuals.

In the simple example given above, only carelessness in examining the residuals would prevent the discovery of the dormant variable, but in the more complicated problems that occur in practice it might require a great deal of insight to make the right inference from the residuals. The prediction method would still work automatically. Of course, if two dormant variables cancelled each other out, or if a variable lay dormant through both periods, neither method would help.

This, then, is the reason—or at least *a* reason—why prediction is the best test of an economic theory. It follows, too, that prediction backwards in time is every bit as good as the more normal forwards prediction, or forecasting.

4.2. *Method of Prediction*

In using the model (23) for prediction, it can generally be assumed that estimates of $X_2, \ldots, X_n, Y_t, p_{0t}$ and t are available. This leaves n equations relating the $n + 1$ variables $P_1, \ldots, P_n$ and X_1, so that any n of them can be predicted, given an estimate of the $n + 1^{\text{th}}$. In particular, it is possible either to start from an estimate of P_1 and predict $X_1, P_2, \ldots, P_n$, or to start from X_1 and predict $P_1, \ldots, P_n$. The latter course was followed in this case, as it is very much simpler arithmetically, and gives results which are just as easy to interpret. It implies, of course, that the supply of new cars is inelastic—which was certainly true in 1947 and 1948, and probably true in 1950–52.

4.3. *The Post-War Data*

The same series as in the original analysis were used for car prices, the general price level, and car registrations. For non-farm population, the series in Table 4 of *The Farm Income Situation* was used. This series gives population at April 1st instead of July 1st, but with a steadily changing variable-like population this involves no great error. The series was also reduced to an index with 1941 = 100, so that the two series give the same figure for that year.

Similarly, a new income series was used. Up to 1950 it was based on the calculations of personal disposable income other than from farm profits in Frane & Klein (1953). Farm wages

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

were subtracted, and it was assumed that these paid no taxes. For 1951 and 1952 it was assumed that non-farm personal disposable income moved proportionally to "national income to persons not on farms" as given in Table 4 of *The Farm Income Situation*. The series used up to 1950 is clearly better than that used for the inter-war years; it was not used originally because Klein's calculations were not then available, but in any case they do not go back further than 1929. The increased accuracy is quite important in view of the big changes in tax structure and distribution of income that took place during the war. The 1951–52 figures are, of course, shaky, but the year-to-year changes in structure are very much smaller than those during the war. The various figures are given in Table 7.

TABLE 7

	Cost of Living Index Average for Year P_0	*Index of Non-farm Personal Disposable Income per Head* Y	*Estimated Numbers of Cars less than a given Age Owned by Non-farm Families at December 31st adjusted to 1941 Population*					
			x_1	x_2	x_3	x_4	x_5	x_6
1947	152·0	105·01	2,680	3,691	3,745	3,772	3,708	17,583
8	163·7	104·92	2,497	4,208	5,710	5,752	5,654	18,693
9	162·1	105·56	4,050	5,417	7,606	9,080	8,925	20,116
1950	163·7	111·83	4,880	7,340	9,459	11,569	12,704	20,974
1	176·8	115·20	4,181	7,449	9,453	12,827	14,527	20,783
2	180·8	117·99	2,363	5,370	8,248	12,708	14,359	21,530

4.4. *Results of Prediction*

The model (23) was applied to the data of Table 7 and used to predict the vector of prices $P_1, \ldots, P_6$ for December 31st of each of the years 1947–52 inclusive. Table 8 gives the actual and predicted price vectors, and the same results are shown in diagrammatic form in Figs. 10–15.

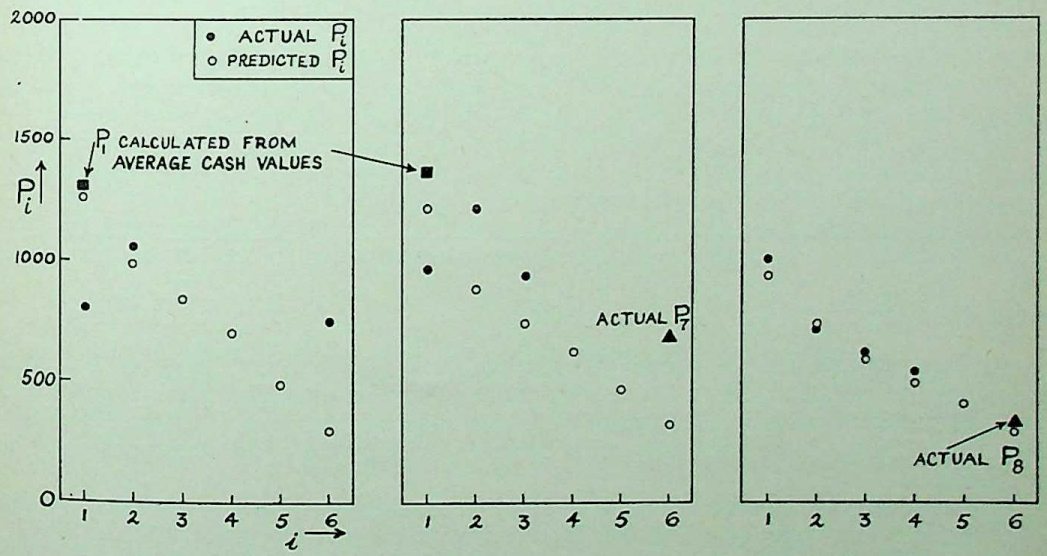


FIG. 10. FIG. 11. FIG. 12.

In 1947 and 1948 new car prices were much lower than predicted and other prices much higher. This is readily explained, for it is generally known that in those years there was a good deal of unsatisfied demand for new cars, the manufacturers having fixed a price for new cars that did not take account of their scarcity value and was therefore below the equilibrium price that would equate supply and demand. A symptom of this is the fact that in both years the listed new car price was less than the price of two-year-old cars. Fixing an unduly low price for new cars will also have the effect of forcing up the prices of used cars, for many people with quite low values

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 8

		P_1	P_2	P_3	P_4	P_5	P_6
Dec. 31st, 1947	Actual	800*a*	1,050	—	—	—	750
	Predicted	*1,279*	*988*	*846*	*701*	*494*	*298*
„ 1948	Actual	970*a*	1,213	940	—	—	*b*
	Predicted	*1,210*	*883*	*742*	*622*	*470*	*311*
„ 1949	Actual	1,000	703	620	537	—	*c*
	Predicted	*939*	*716*	*594*	*496*	*408*	*295*
„ 1950	Actual	980	900	713	647	567	*d*
	Predicted	*852*	*656*	*547*	*464*	*398*	*309*
„ 1951	Actual	1,033	960	807	650	557	493
	Predicted	*965*	*727*	*609*	*511*	*450*	*362*
„ 1952	Actual	1,091	940	787	653	523	460
	Predicted	*1,175*	*799*	*650*	*538*	*471*	*377*
May 15th, 1953	Actual	1,091	824	689	570	441	380

a. As noted in section 3.3, P_1 was calculated as $\frac{2}{3}$ new price. However, calculated on the basis of average cash value, P_1 was 1,293 in 1947 and 1,373 in 1948.

b. No value of P_6, but $P_7 = 670$.

c. „ „ „ $P_8 = 307$.

d. „ „ „ $P_9 = 320$.

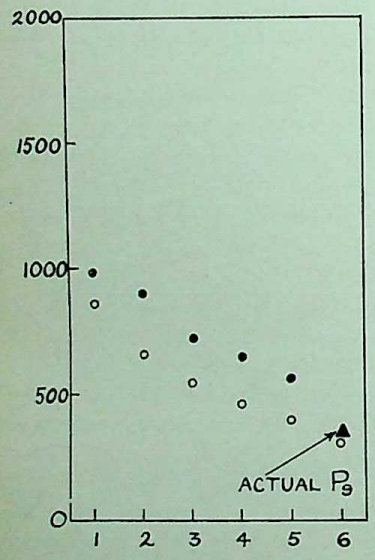


FIG. 13.

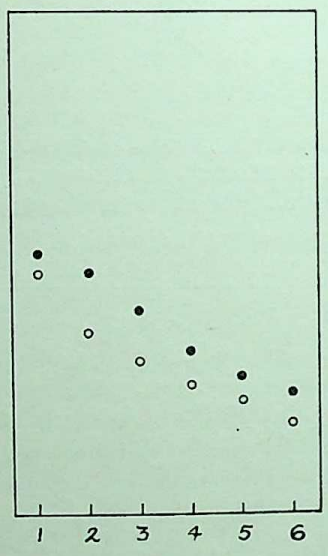


FIG. 14.

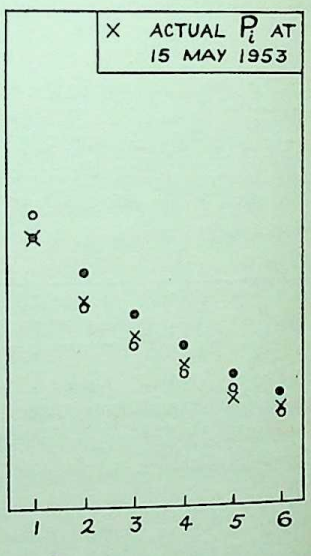


FIG. 15.

of η will buy new cars, and the people they displace, having higher values of η, will bid up the price of two-year-old cars above the equilibrium level, and so on. The relationship between actual and predicted prices in 1947 and 1948 is thus quite compatible with the predicted prices being the equilibrium prices, and the market being distorted by the unduly low price set by the manufacturers.

A further check can, however, be made by substituting the second-hand price of cars less than a year old for the new price. In 1947 this is quite close to the predicted price, while in 1948 it is somewhat above it. As relatively few new cars were re-sold within a year—the practice constituted a sort of black market—it might be expected that this price would be higher than the equilibrium price, on the argument of the last paragraph. Thus the model has predicted quite satisfactorily for 1947 and 1948, so far as can be ascertained the lack of any quantitative knowledge of the effects of the frustrated demand for new cars reduces the stringency of the test. However, it may be noted that the difference between actual and predicted P_6 in 1947, and that between actual P_7 and predicted P_6 in 1948, are very large, so large that it must be suspected that there was a genuine underestimate of P_6.

In 1949 there was a remarkably close agreement between actual and predicted prices, except

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

again for P_6—the predicted P_6 was less than the actual P_8. In 1950 and 1951, however, the predicted prices were systematically lower than the actual prices. This may have been due in part to stockpiling on account of the Korean war, but, if it was not due to simple error on the part of the model, it was probably caused by expectations. The model deals only with purely economic factors, but expectations always play a part in the market.* There may be no reason in the demand functions why prices should remain at a given level, but if the market expects them to do so, then they will. Any market can hang from its own bootstraps, often for considerable periods.

In 1952 new car prices were over-estimated, but all the other prices again under-estimated. This could be explained by the fact that the demand for new cars had already fallen, but that used car prices were maintained at a high level by expectational factors. This would mean that a slump in used car prices was imminent. The actual prices for May 15th, 1953, show such a slump, and indeed are very nearly the same as those predicted for December, 1952. If it is objected that by May, 1953, the cars were all five months older, and should in any case have been cheaper, it may be retorted that May is just the month when car prices are seasonally high, and that most of the fall in price from one year to the next occurs in the summer and autumn.

Thus, unless it is felt that three years is too long for a market to hang from its bootstraps, the model has come through with flying colours. The whole argument about expectations has, however, underlined the fact that they are not, and indeed cannot easily be, included in the model, so that although it can predict changes in prices, it is likely to be badly out as to timing. There was also some evidence that it under-estimated the prices of very old cars at least up to 1949. This was very probably because there was, in the immediate post-war period, a marked increase in the social acceptability of very old cars—another factor the model does not allow for. Incidentally to judge from the later figures, that social change was purely temporary. Alternatively this under-estimate may have been due to a variation in the average age of cars in the oldest group —"more than five years old" is a very wide group.

Finally, the results can be used to illustrate another factor the theory does not allow for—an important change in design. There was such a change in 1949, and the difference in price between 1949 and 1948 models has been markedly greater than predicted ever since. P_1–P_2 in 1948, P_2–P_3 in 1950, P_3–P_4 in 1951, P_4–P_5 in 1952—in each case the actual difference is a good deal greater than the predicted difference. Finally, the model does not allow for the redistribution of income, or for the effects of the growing number of families owning two or more cars.

Thus the model deals well with some factors and ignores others. Its success is bound to depend on the job it is asked to do. It is designed to relate demand to income, prices and the stocks of used cars. Where these factors are important—after a war or during a slump—it may be expected to predict demand efficiently. On the other hand, in something approximating a stationary state, demand is likely to depend more on changes in tastes or in designs, and the model will be relatively useless. A steadily expanding economy is probably an intermediate case.

References

ALLEN, R. G. D., & BOWLEY, A. L. (1935), *Family Expenditure*. London: Staples.

DEWHURST, J. F., *et al.* (1947), *America's Needs and Resources*. New York: Twentieth Century Fund.

DE WOLFF, P. (1938), "The demand for passenger cars in the United States", *Econometrica*.

FARRELL, M. J. (1954), "Some aggregation problems in demand analysis". *Rev. Econ. Stud. XXI*.

FINNEY, D. J. (1947), *Probit Analysis*. Cambridge University Press.

FRANE, L., & KLEIN, L. R. (1953), 'The estimation of disposable income by distributive shares", *Rev. Econ. Statist.*, 35, .

HOUTHAKKER, H. S. (1952), "La Forme des Courbes d'Engel", *Cahiers du Semininaire d'Econometrie*. Paris: Medicis.

MALMQUIST, S. (1948), *A Statistical Analysis of the Demand for Liquor in Sweden*. Uppsala: Appelbergs bocktrycheri.

ROOS, C. F., & VON SZELISKI, V. (1939), "Factors governing changes in domestic automobile demand", *Dynamics of Automobile Demand*.

TOBIN, J. (1950), "A Statistical demand function for food in the U.S.A.", *J.R. Statist. Soc.*, A, 113, 113–149.

United States—Bureau of the Census (1949), *Historical Statistics of the United States*, 1789–1945. Washington: G.P.O.

United States—Department of Agriculture (1948), *Agricultural Statistics*, 1947. Washington: G.P.O.

* More accurately, the theory assumes unit elasticity of expectations, but this elasticity is often markedly different from unity in the actual market.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Discussion on Mr. Farrell's Paper

Mr. W. J. Corlett: I should like to congratulate Mr. Farrell on the skill and ingenuity with which he has tackled one of the most difficult problems of demand analysis. The study of the demand for motor-cars combines both the difficulties associated with durable commodities and those arising from considerable quality changes over the period for which we can do a time series analysis. As Mr. Farrell pointed out, several attempts have been made to tackle this problem, but one has never felt convinced that a solution has been found.

Mr. Farrell has used the combination of family budget data and time series data which has become so popular in recent years, particularly in the work done in connection with the Cambridge Department of Applied Economics. The family budget investigation involves factual assumptions that all cars of a given age can be treated as homogeneous and that individuals or families possess only one car. I cannot say how closely these are approximations to reality in the United States, but, apart from that, the analysis appears to rest on rather simple foundations. We could start, although Mr. Farrell does not, from the assumption that the higher a man's income the better car he will buy, and that he will go gradually from one car to the next better as his income increases. Different individuals have different incomes at which they switch from an i year old car to an $i-1$ year old, but it is assumed that individuals differ only in a single multiplier which would give the same points of switching for all. This multiplier is assumed to have a logarithmic-normal distribution. From the data, the standard deviation of the distribution, and the income for which half the individuals will have an i year old car or newer, are estimated. The assumption about the existence of the multiplier and its distribution might seem drastic, but clearly some such assumption is needed if any analysis is to be made.

Mr. Farrell has, however, tried to carry the work further back and base his assumptions on some sort of utility analysis. In doing so I think he has got on to much more shaky ground. It may not matter much for the cross-section analysis, but it seems to be crucial for his work on time series.

The first point on which I feel dubious about the theoretical model is at the first introduction of U_{ik} after assumption C. The second inequality in equation (3) seems to be an assumption, although it is not stated to be one, and it is not at all clear to me that it is a realistic assumption. It appears, for instance, quite possible that a man who really needed a car would be willing to pay almost the same price for it, if it were the only one available to him, no matter whether it was new, one, two, three, or even ten years old. When, however, he has a choice of cars, he may quite rationally be prepared to pay a considerably higher price for the new car. In other words, he may own an i year old car even if U_{ik} and U_{jk} are approximately equal and P_i is much greater than P_j. For much the same reason I feel doubtful about the assumption G which appears essential for the rest of the analysis. The whole of this theoretical framework seems to be based on the idea of maximizing some form of consumer's surplus. It appears to involve an assumption of constant marginal utility of money, which does not seem appropriate when discussing the purchase of a commodity costing as much as a car.

Even if we accept the utility foundations, I am not convinced that equation (5) can be interpreted as a demand function. The way in which the model functions is that the fixed number of cars of each age determines how far we have to go down the adjusted income scale to get a point of switching (by adjusted income I mean after allowing for the multiplier u—in fact η). From the utility assumptions, these points of switching determine price differences between different models in equilibrium. They also determine actual prices. The p's in equation (5) are, then, equilibrium prices. As long as they remain so, the equation does not seem to have any meaning whatever. We can interpret equation (5) as a demand function for small changes of the p's from equilibrium, but I cannot see how we can go any further.

When we come to equation (6), which is the one that is really used, we are on safer ground. This shows prices being determined by the model. The equations (7) are formally possible although they obscure the working of the model. They also, however, lead to a certain clumsiness in the later parts of the paper. For example, in the estimation procedure with time series the introduction of k_{it} is unnecessary. Equation (19) simply determines the appropriate value of η/Y_t. The remainder of the estimation consists of fitting the relation between the p's and the η's, i.e., equations (6) which are assumed to be linear.

I think it might be possible to justify relations of this form either as an assumption on behaviour with equilibrium prices or on rather more satisfactory utility foundations. In that case the remainder of Farrell's method could be used.

I should like to say a little about Farrell's attempt to test his model by comparing predicted and actual prices for 1947 to 1953. As he rightly points out, econometric models may give a good fit with small standard errors, yet they may break down when used for prediction because of the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

operation of other variables. This means that we should not place too much reliance on the use of standard errors. I assume, however, that Mr. Farrell would agree that a model cannot become better than is indicated by its standard errors. Standard errors have a place in putting an upper limit on the accuracy which can be expected from prediction. If forecasts based on large standard errors work out well in prediction, we have simply been lucky. It is for this reason that I think it would be useful if Mr. Farrell were to give figures for standard errors where possible; the low values of R^2 make one suspect large standard errors.

In his predictions of prices Mr. Farrell does get some large deviations from actual prices which he proceeds to explain away. This seems an example of the sort of explanation usually found in econometric models—something has happened to disturb the model. He implies that with the end of the disturbing factors the model will give satisfactory results, and as a check on this he gives May, 1953, prices. I should be interested to know what has happened since then. If the prices of second-hand cars have been falling steadily, actual prices were likely to pass close to predicted prices at some point. Was May, 1953, simply that point?

I should like to move a vote of thanks to Mr. Farrell and congratulate him once more on his paper. I do not think that one can follow him completely in saying that the model has come through with flying colours, but one is grateful for a most interesting and skilful piece of work on a very difficult subject.

Mr. G. MORTON (in seconding the vote of thanks): I am very grateful to Mr. Farrell for his interesting and stimulating attempt to bring the theory of durable consumers' goods under control and to measure the demand for them. I am not, however, entirely happy about the data used. I should be glad if Mr. Farrell could tell us what happens to new cars remaining in the hands of dealers for, say, two years: do such cars count as new or as 2-year-old cars when they are sold, or is the number of such cars too small to make much difference? From Mr. Farrell's data I have extracted the next two tables giving the life histories of cars.

(Derived from Table 5 of Mr. Farrell's Paper)

	x_{1t}	$(x_2 - x_1)_{t+1}$	$(x_3 - x_2)_{t+2}$	$(x_4 - x_3)_{t+3}$	$(x_5 - x_4)_{t+4}$	$(x_6 - x_5)_{t+5}$
1922	2,685	1,385	2,087	1,847	1,143	181
1923	4,225	2,690	3,197	2,706	1,961	671
1924	3,910	2,352	2,899	2,609	1,903	849
1925	3,898	2,403	3,118	2,864	1,970	1,237
1926	4,071	2,754	3,313	2,902	2,139	2,030
1927	3,084	1,840	2,483	2,225	1,741	2,779
1928	3,821	2,291	3,058	2,820	2,387	4,289
1929	4,466	3,101	3,634	3,582	3,330	6,662
1930	2,900	1,971	2,317	2,298	2,047	7,365
1931	2,067	1,552	1,801	1,748	1,540	7,126
1932	1,196	708	1,002	980	777	5,937
1933	1,583	941	1,321	1,304	1,018	5,468
1934	1,941	1,163	1,679	1,629	1,336	5,475
1935	2,523	1,454	2,092	2,008	1,722	5,608
1936	3,481	2,194	2,866	2,825	2,504	6,278
1937	3,660	2,684	3,036	2,989	2,666	—
1938	1,776	1,037	1,524	1,455	—	—
1939	2,447	1,460	2,051	—	—	—
1940	3,101	1,841	—	—	—	—
1941	3,926	—	—	—	—	—

(Derived from Table 7 of Mr. Farrell's Paper)

1947	2,680	1,711	2,189	2,110	1,700	7,171
1948	2,497	1,367	2,119	3,374	1,651	—
1949	4,050	2,460	2,004	4,460	—	—
1950	4,880	3,268	2,878	—	—	—
1951	4,181	3,007	—	—	—	—
1952	2,363	—	—	—	—	—

It is obvious that cars listed in the first column of my table must appear in all the following columns unless they are sold to the farm sector, laid up or scrapped. The differences between the first and second columns appear too large for such explanations. Similarly a column can only be larger than a preceding one if cars "migrate" from the farm sector, or if cars that were laid up are re-registered. Again, the increase from the second to the third column is too large to be

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

accounted for in such a way. Finally, Mr. Farrell's column (x_6) is too large unless, as I suspect, it is not the total of cars up to six years but of all cars. In that case, the column x_6 seems too small since, e.g., the total of cars registered in 1947 was about 31 mn. whereas Mr. Farrell's figure for the non-farm sector is 18 mn. and 13 mn. cars seems too high for the farm sector. I wonder if Mr. Farrell can help us to reconcile these conflicting data?

Finally, stimulated by Mr. Farrell, I have set up a model of my own. My fit is better than his, the ratio of predicted to actual values for the p_1 and p_2 series is:

Predicted Values / *Actual Values*	p_1		p_2	
	Farrell	*Morton*	*Farrell*	*Morton*
1947 (December) . .	1·61	—	0·94	—
1948 (December) . .	1·25	0·82	0·73	0·87
1949 (December) . .	0·94	0·97	1·02	1·73
1950 (December) . .	0·87	1·02	0·73	0·78
1951 (December) . .	0·93	0·95	0·76	0·94
1952 (December) . .	1·08	0·95	0·85	1·02
1953 (May) . . .	—	1·00	—	1·14

It will be seen that in all cases but one my percentage error is less than his. My "model" has the sole merit of simplicity—it consists of the hypothesis that prices next year will be equal to this year's prices. This does not, of course, detract from the value of Mr. Farrell's work, but it leads to the question of his purpose in setting up a model of this kind. It cannot be used to guide manufacturers, dealers or importers, since to predict prices in any one year it requires several variables which will be known only at the end of that year (or later). At the same time it does not tell us much about the general characteristics of the market.

Even though I have been playing the devil's advocate, I should like to repeat that I have enjoyed Mr. Farrell's paper very much. It gives me great pleasure to second the vote of thanks.

The vote of thanks was put to the meeting and carried unanimously.

Professor CHAMPERNOWNE said that he had been very much impressed by the ingenuity of the paper and he thought that Mr. Farrell should be able to reply adequately to many of the criticisms made by Mr. Corlett. He agreed with Mr. Corlett that it would be very interesting to have some statement about the error variance of the predictions. He himself had felt that the degree of agreement was perhaps in some cases a fluke. Although he disagreed with some of the earlier criticisms he did feel that assumption K in the paper was a rather dangerous one, namely, that the shape of the income distribution remained constant throughout the period, and he was wondering since that assumption was made whether in view of the very good fit of the figures given of the cross-section data, the estimates of the spread of the taste variable u were really as useful in interpreting the time series as one might have hoped.

The question he had asked himself was whether the modification of income distribution to the adjusted income distribution because of the taste factor was really as important as the fact of the change in income distribution itself over the period. One could not get far in answering that question by theoretical considerations, although it could be shown that if the income distribution was an exact Pareto distribution down to such a level that nobody at that lowest income would own a car at all, then a false estimate of the dispersion of tastes would have no effect on the predictions of car prices. However, they all knew that income distribution did not obey Pareto's Law down to this level.

In attempting to get some further answer he had made his own model. He had chosen a set of prices and quantities of cars which would exactly fit Mr. Farrell's model and worked out a prediction of prices. Denoting the logarithm of income by y', he had assumed a two-tailed Pareto distribution of income of the form

$$f(y') = \frac{\alpha}{2} e^{-\alpha | y' - y'_t |}$$

where the parameters α and y'_t changed from year to year. Denoting the logarithm of u, the taste variable, by u', he had assumed a similar form for the distribution of u',

$$g(u') = \frac{\beta}{2} e^{-\beta | u' |}$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

He had confined his model to the seven dates, 1, 2, 3, 4, 5, *a*, *b*, and to three grades of car, 1, 2, 3. He had predicted prices of cars in years (*a*) and (*b*) on the basis of figures (see Table 3 below) for the years 1, 2, 3, 4, 5 and on the basis of two alternative false sets of assumptions about α and β. In Table 1 the values thus assumed for α and β are compared with the "true" values built into the model.

TABLE 1

"True" and Assumed Values of α and β

		1	2	3	4	5	*a*	*b*
True values	α	1·4	1·45	1·5	1·55	1·6	1·8	2·0
	β	1·6	1·6	1·6	1·6	1·6	1·6	1·6
Values in assumption 1	α	1·6	1·6	1·6	1·6	1·6	1·6	1·6
	β	1·6	1·6	1·6	1·6	1·6	1·6	1·6
Values in assumption 2	α	1·4	1·45	1·5	1·55	1·6	1·8	2·0
	β	∞	∞	∞	∞	∞	∞	∞

Assumption 1 ignores changes in income distribution but allows for the dispersion of tastes. Assumption 2 allows for changes in income distribution but ignores the dispersion of tastes.

The results of predicting the prices of the 3 types of car by the two methods are compared in Table 2 with the "true" values in years (*a*) and (*b*):

TABLE 2

Predicted Car Prices

	Year (*a*)			Year (*b*)		
Grade	1	2	3	1	2	3
True price predicted	370	250	140	350	270	180
Assumption 1	324	217	113	260	195	124
Assumption 2	392	247	130	422	287	169

These calculations lent a slight support to the view that to ignore changes in income distribution might be more dangerous than to ignore the effect of the dispersion of tastes.

Later Professor Champernowne supplied the following table of further data on which his model was based:

TABLE 3

Quantities and Prices of Cars and Arithmetic Mean Income

Year	1	2	3	4	5	*a*	*b*
A.M. Income	150	160	130	170	200	240	300
Car Prices:							
Grade 1	372	323	373	292	300	370	350
2	144	130	173	155	200	250	270
3	86	71	97	84	100	140	180
Car quantities							
q_1	61·4	80·8	62·5	126·5	203·5	238·5	436·3
q_2	257·1	269·3	147·6	191·7	45·8	59·0	73·7
q_3	49·9	119·0	115·4	163·4	256·9	218·0	41·9

q_1, q_2, q_3 denote the numbers per 1,000 income-receivers, who own cars in grades 1, 2 and 3 respectively.

Mr. R. F. F. DAWSON said that the author had pointed out how his theoretical model might accurately fulfil what he claimed for it, but the question was how it could be adapted to other purposes.

Could it be used, for instance, for other consumer-durable goods? In most cases the situation was much simpler as the second-hand market was of little importance and there was not a large body of consumers who always wanted, say, a refrigerator not more than a year old. The only occasion when this was likely to happen was when there was a radical change in design, and as Mr. Farrell pointed out, his model did not cover such a situation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

How could it be used for cars in the United Kingdom as distinct from the United States? The first drawback was the non-availability of budget data and the fact that they were more difficult to collect in this country because of the much smaller percentage of people who owned cars—about 8 per cent. as compared with 60 per cent. in the United States. Mr. Farrell had used figures relating to income levels at which 50 per cent. of the families owned cars of a certain age, but in this country one reached an income level of about £1,000 a year before 50 per cent. of families had a car of any age. As Mr. Farrell pointed out his assumption "A" would be less true in this country and any allowance for that would complicate the model. On the other hand ownership of two cars was less important in this country where something under 0·5 per cent. of families owned two cars, whereas in the United States the figure was 4 to 5 per cent. of families and about 8 per cent. of all car owners. The turnover in cars in the United Kingdom was also relatively small. In 1952 about one-fifth of the people who at the end of that year owned a car had bought a car during the year; in the United States in the years 1949–53 about 40 or 45 per cent. of all car owners had bought cars during each year. This probably affected the results of the model more than its application. But perhaps the greatest difficulty in applying the model to the United Kingdom would arise from the restrictions imposed by the Government in relation to the home and export markets and also the ban of manufacturers on the reselling of cars.

Mr. W. F. Harris admired the ingenuity with which Mr. Farrell had developed his theoretical model. The elimination of unimportant factors and the absence of desirable information were typical of the many difficulties which Mr. Farrell had to overcome. The study was, however, modest in its aim, and was no solution to the problem of demand forecasting. There were too many questionable assumptions, too many facts ignored, too many facts unknown and too wide margins of error to justify confidence in the results which, when evaluated, had to be explained away. Like much cruder techniques, it arrived at a result which was only susceptible of reconciliation with events after the events had occurred. As with these techniques the latent factors still interfered with the result and this technique made them no less latent. It was unfortunate—even if inevitable in a study of this nature—that so many rough and ready assumptions had to be made: one was left with the impression that even where the forecast results came well into line with events, the author had been smiled upon by the God of Compensating Errors.

One important question mark left in one's mind was fundamental to the whole study. Was there such a thing as a random distribution of taste? Was there such a thing as *average* taste? Surely, taste was qualitative and the very expression "random distribution of tastes" was meaningless. The assumption that tastes varied with income did not line up with facts, especially in the motor car business. Too many cars were run for or by businesses, and the economics of car-running were severely affected by taxation statutes. Another doubtful assumption was the "single car" family, especially in the United States. Another more fundamental question was whether the series of interrelated markets did not extend to other durable goods markets. Television sets, washing machines, refrigerators, houses and furniture all competed for the consumer's preference and there was a distinct absence of evidence that the cross-section data were sufficiently reliable and sufficiently invariable over a period of time to isolate the effect of shifting consumer preference patterns.

None of these criticisms, however, was intended to belittle the usefulness of the work which had been done. If forecasting was ever to be a science it needed the thought and analytical work which Mr. Farrell had given to his study: the Society should be grateful for his contribution. It was to be hoped that Mr. Farrell would tackle the demand problems of British manufacturers where institutional restrictions in the export markets were by no means the least difficult factors to quantify.

Mr. A. G. M. Webster said he had no model of his own. He was no real statistician, but had had experience of the actual pricing of models and was also concerned to some extent with the determination of forward demand. As regards this extremely ingenious thesis—he was afraid that most of them used the same word, ingenious, to describe it—there were certain important factors which seemed to be overlooked or underrated when considering it as a practical proposition for application. He was very glad to see academic research but he always hoped that it could be turned to practical use, and frankly, so far, he did not see how what had been presented to them that evening could be so turned.

One of the major things that seemed to be overlooked (he had not had time to go over the parts of the paper which the author had left unread) was the question of business allowances, capital or revenue, affecting demand without regard to the income of the nominal owner; this could be

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

very important. Another major point was that the answer still hung very much on the forecast of forward economic conditions, one of their major worries when trying to determine forward demands. There were also certain other assumptions which applied more in the United States than in this country.

Mr. Farrell's assumption D was that people would prefer a new car to an old car, but even this did not always apply. To take an obvious example, quite a number of people preferred an old Bentley to a much newer sports car of the same price. When a man married—and the figures taken included the household as a unit—his taste in cars might be found to have changed, and many an unfortunate married man found that he had a saloon car on his hands. There were many little points of that kind. Another was that it was assumed that when a family sold a car and bought another it could be classified merely as a transfer. There was, however, a special case arising under certain conditions which should be noted. It was not always merely a transfer because sometimes the dealer was left with the car which was surrendered. At the present moment in the tractor market dealers were sometimes accepting old tractors in part exchange to keep business going and getting left with them on their hands. In other words, there was an intermediate class of people to be considered, who in course of business might create demand at the very time it was falling off.

The adaptation of this study to the United Kingdom would be difficult. The manufacturer had no information with regard to the total number of vehicles in this country analysed by age-groups. His firm had tried to get the analysis from the licensing authorities, but they would not help, though later they said that they would furnish the information if his firm provided all the necessary equipment, the computers and so on, for the analysis. The cost could readily have been borne by the motor-car industry collectively, but the industry was not united on the subject. They also lacked information on incomes and budgets, but he could state that the second-hand prices mentioned by a previous speaker were available in a more or less accepted form within the trade.

Mr. M. J. FARRELL, in reply, said that various people had commented on the fact that he had predicted prices rather than demand. He had done this because the arithmetic involved—the sheer multiplication and division—in predicting demands would be very much greater than in predicting prices, and he felt it was not worth while to undertake such computations for the sake of putting it in terms of demand when the theory could be tested equally well in terms of prices.

Secondly, various people had said that the predictions depended on predictions of other variables. This was common to all attempts to predict the demand for a product. In predicting a demand for butter one could only predict in terms of an estimate of the national income and an estimate of the price of butter. One had to predict these variables before one could predict the demand for butter. This was true of his model.

He hoped that he would be able in the near future to make some application of this to the demand for cars in the United Kingdom. He had already made enquiries which showed that it would be much more difficult here than in the United States because of the relatively scanty data which were available, but he hoped to make an attempt, possibly with a simplified model.

Finally, he would refer to Mr. Morton's comment, as this contained some misunderstandings that could quickly be cleared up. The first of these concerned the estimates of the X_{it} which Mr. Morton had so ingeniously extracted, and from which he had produced so many paradoxes. He (Mr. Farrell) would like to emphasise the heading of Table 5. The figures for X_{it} had been adjusted to allow for business ownership, for ownership by farm families, and for changes in population. It was therefore not surprising that taking first differences should yield paradoxes. He would gladly supply Mr. Morton with more data from which he might satisfy himself that these paradoxes did not really arise.

With regard to Mr. Morton's very interesting model, it was the sort of "naive model", as they were called in the United States, that was very fashionable nowadays. They often appeared to be more successful than the more elaborate models with which they were meant to be compared, but there was usually a catch. In this case, this could best be seen by noting that Mr. Morton gave no prediction for 1947. Given 1947 prices, it was not so difficult to predict 1948 prices. Mr. Farrell's model was meant to predict 1947 and subsequent prices, starting from 1942—something which Mr. Morton's model did not attempt.

Mr. FARRELL subsequently replied in writing as follows:

I am grateful to Mr. Corlett for pointing out a slip in the utility analysis. As it stands, I imply a constant marginal utility of money. However, define D_{ijk} as that difference in price between i and j year old cars that will leave the kth individual indifferent. Write D_{ijk} for $U_{ik}-U_{jk}$ in (3), and the subsequent argument holds, *mutatis mutandis*, while the odious assumption is avoided.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

I am, however, baffled when he objects to my model's determining equilibrium prices. My demand functions are perfectly ordinary demand functions, and differ from demand functions for, say, butter, only in that they deal with stocks instead of flows. Their intersections with my supply functions determine equilibrium prices, just as in the case of butter. What would he have the intersection of a pair of supply and demand curves determine, if not the equilibrium price?

Table A below gives the actual and predicted prices at December 31st, 1953. The predicted prices are only very provisional estimates, being based on rather rough guesses at the values of the predetermined variables. It will be seen that new car prices were much higher than predicted, but used car prices much lower, especially the prices of the oldest cars. This is partly explicable as an increased premium on new cars, due either to the introduction of a new model or to a change in public tastes. This would both raise new prices and depress used prices. However, it is doubtful whether the whole of the overestimate of the prices of older cars can be attributed to this, and the remaining part must be regarded as due once again to expectations or as pure error.

TABLE A

	P_1	P_2	P_3	P_4	P_5	P_6
Dec. 31st., 1953, Actual . .	1071	720	563	462	364	278
Predicted	*1015*	*787*	*638*	*530*	*464*	*375*

In response to the requests of Mr. Corlett and Professor Champernowne, I give estimates of the standard errors or estimate of the P_i in Table B. They are based on the variance of the difference between the actual and predicted values of the Y_i, and thus correspond to the R'^2 of Table 6.

TABLE B

Variable	P_1	P_2	P_3	P_4	P_5	P_6
Estimated s.e. of prediction .	30	40	36	31	23	17

Professor Champernowne's model is a very interesting one. I think everyone will agree with him that changes in the distribution of income may be so large that their effects become more important than those of other factors. It is impossible to determine from the data whether or not this was so for the United States in the period considered; but the changes that took place in the distribution of income seem to have been much smaller than those Professor Champernowne assumes for his model.

Mr. Dawson points out that it is more difficult to apply my model to other commodities or other countries. This is true, but not surprising. I chose the American car market because of its homogeneous product, well developed second-hand market and plentiful statistics.

Mr. Webster and Mr. Harris emphasised a number of difficulties in applying my model to the United Kingdom. Lack of statistics, greater heterogeneity of product, greater importance of business ownership and business allowances—they make a formidable list. The greatest difficulty in using such a model to predict the demand for an individual manufacturer's product is that the model only estimates the total demand. The share of the market secured by any individual firm will vary from year to year, and if the market is an overseas one, this share may vary violently and unpredictably.

In reply to Mr. Harris's comments on tastes, I can only say that if he will re-read my paper he will see that I attach a perfectly clear meaning to a random distribution of tastes, and that so far from suggesting that tastes vary with income, I assert that they do not.

Finally, I should like to recur to the point about my predictions depending on variables that are not known for certain until after the event, and which must therefore be predicted before my model can be used to forecast demand or prices. This objection is raised by Mr. Morton and Mr. Webster. Of these variables, population and the number of used cars of different ages are quite easy to forecast with reasonable accuracy. There remain the level of national income and of the cost-of-living index. My model expresses prices and demand for cars in terms of these two variables, and in order to forecast prices or demand one must first make (or borrow from some other source) estimates of these two variables. Not only is this the common practice with demand analyses, it is also in accord with the principle followed in every aspect of life. One does not, for example, expect a car to include a built-in oil refinery!

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Geoffrey Newman Alexander.
Richard Marmaduke Bell.
John Lloyd Clay.
Sydney Elvin Cruise.
Abdelmegid Moustafa Farrag.
Finlay Gow Forsyth.
Gangadhar Shrishailappa Gouri.
Victor Mark Green.
Narindra Nath Handa.
Geoffrey Harrington.
Mohammed Khaled.
Jacob Preger.
Paul Roberts.
Alan Arthur Russell.
Walter Trevor Stott.
Frank Pilling Thompson.
William Whinham Thompson.
Manohar Khanderao Vagholkar.

Corporate Representative:

John Percival Wynne Willson, representing The Imperial Tobacco Co. Ltd.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Pairing of Observations in Ordered Samples from a Normal Population

By D. R. Read, P. G. Smith and J. H. Ince

The Distillers Co. Ltd., Great Burgh, Epsom

SUMMARY

Given an ordered sample of n observations $X_1 \leqslant X_2 \leqslant \ . \ . \ . \ \leqslant X_n$ drawn at random from a normal population with known standard deviation σ, let m be the (maximum) number of pairs (X_i, X_{i+1}) that can be formed so that for each pair the difference $(X_{i+1} - X_i)$ is not greater than a given quantity d, with the restriction that no observation is used more than once. In the present note we consider the mean value of m, for $d = 0{\cdot}1\sigma$ or $d = 0{\cdot}05\sigma$ and values of n up to 200, and give an approximate solution obtained by sampling from a table of random normal deviates.

We consider the following problem. Given an ordered sample of n observations

$$X_1 \leqslant X_2 \leqslant \ . \ . \ . \ \leqslant X_n$$

drawn at random from a normal population with known standard deviation σ, let m be the (maximum) number of pairs (X_i, X_{i+1}) that can be formed so that for each pair the difference $(X_{i+1} - X_i)$ is not greater than a given quantity d, with the restriction that no observation is used more than once. It is required to determine the distribution of m, and in particular to obtain the mean value of m. Numerical solution for the moments of m with any particular values of d, n and σ would appear to be rather difficult and, so far as we know, the problem has not yet been treated in the literature: but a definite practical requirement for its solution has arisen in our own department.

The practical problem relates to manufacture of a quartz dumb-bell which is the test piece in a magnetic oxygen meter. The dumb-bell, consisting of two hollow spheres of diameter about 2·7 mm., connected by a rod of length about 4·6 mm., has to be made by hand, and it is not practicable to make a single sphere of any predetermined weight. Within certain comfortably wide limits the weight of either sphere alone (about 2 mg.) is immaterial, but the weights of the two spheres for any one dumb-bell must not differ by more than 0·04 mg. (and preferably by not more than 0·02 mg.). The problem is to determine the number of spheres which must be made in order that a given number of such pairs will be obtained with reasonable certainty. It is necessary, of course, to make some assumption concerning the *form* of the weight distribution that will be obtained in practice, and it seems reasonable to assume, at least as a first approximation, that this distribution will not be substantially different from normal. From a sample of 28 spheres the mean weight was 2·04 mg. and the standard deviation was estimated to be 0·41 mg. (Since the coefficient of variation is relatively large, it might be better to assume a log-normal distribution of weight: but from the 28 sample values there was no definite evidence of non-normality.)

In the present note we consider the mean value of m in a sample of size n, and give an approximate solution obtained by repeated sampling from a table of random normal deviates (Wold, 1948). It is not suggested that these results have any substantial theoretical value: but it is felt that they may be of some general interest. We ourselves were somewhat surprised at the relatively small variance of m. We hope that this contribution may stimulate other statisticians to investigate the problem and to derive at least an approximate expression that could be evaluated numerically without great difficulty.

Random Sampling Results

The critical weight differences of 0·04 mg. and 0·02 mg. correspond to 10 per cent. and 5 per cent. of the standard deviation, or 0·10 and 0·05 in a population with unit standard deviation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In order to allow for the rounding in the tabulated deviates, the observed values of m were decreased by one-half of the observed frequency of the number of pairs in which the members differed by exactly the maximum permissible amount. The sampling results are given in the table below and presented graphically in Fig. 1.

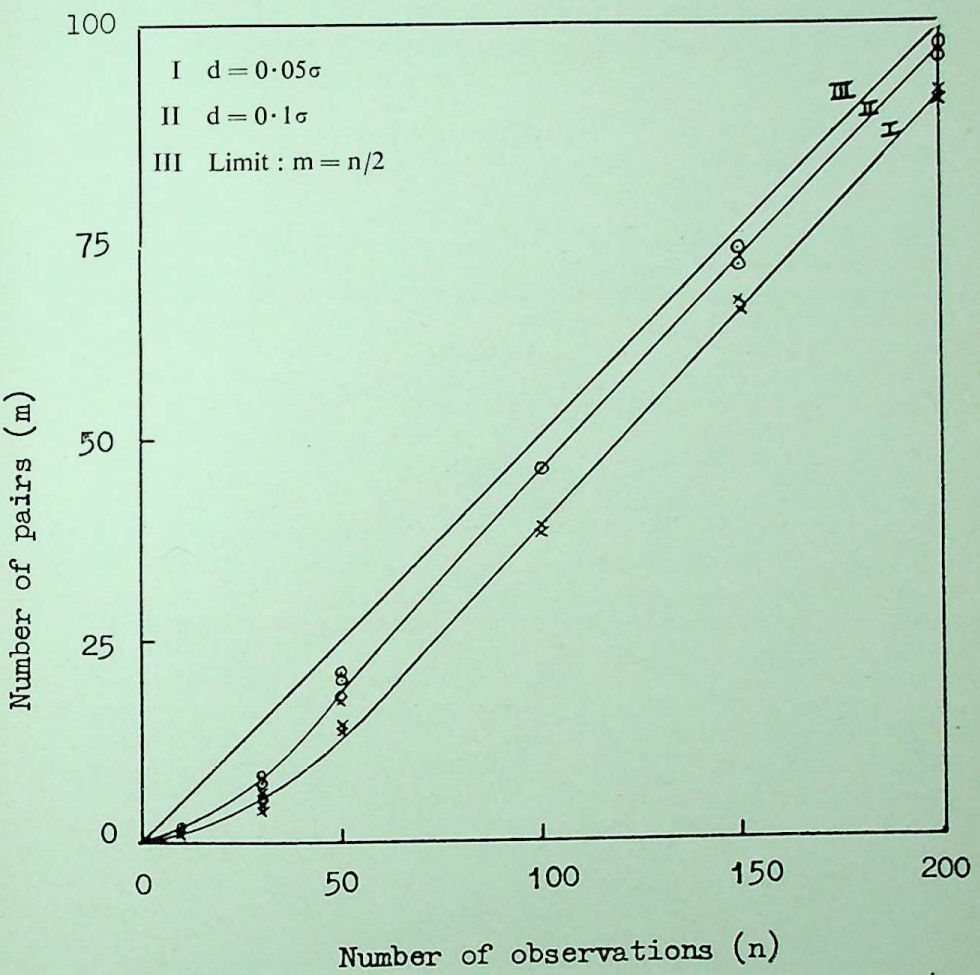


FIG. 1.—Number of pairs (m) differing by not more than d. (In order to avoid confusion, at $n = 10$ only the mean values of m have been plotted.)

	Values of m	
n	$d = 0{\cdot}1\ \sigma$	$d = 0{\cdot}05\ \sigma$
10	1, 1, 2, 3, 4	0, 0·5, 1, 1·5, 2·5
25	5·5, 7·5, 8·5	4, 4·5, 6
50	18, 20, 21	14, 14·5, 17·5
100	46, 46	38·5, 39
150	71, 73	65, 66·5
200	96·5, 98	91, 92

The curves in Fig. 1 have been fitted by eye, bearing in mind that they must be asymptotic to the line $m = n/2$. It is interesting to see the rapidity with which the average number of *unpaired* observations reaches a maximum, and the slowness with which it subsequently decreases.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Thanks are due to the Directors of The Distillers Company Limited for permission to publish this note.

References

WOLD, H. (1948), *Tracts for Computers, No.* XXV*: Random Normal Deviates.* Cambridge University Press.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Wholesale Prices in 1953

By the Editor of "The Statist"

Method of Construction of the Index Numbers

The following table illustrates the method of construction of the index numbers. The index numbers here given are based on the average prices for the eleven years 1867–1877. Take, for instance, the *Gazette* price of English wheat:

	s.	d.			
Average, 1867–77 . . .	54	6,	average point.		
,, 1914 . . .	35	0,	64 or 36 per cent.	*below*	the average point.
,, 1930 . . .	80	7,	148 ,, 48 ,,	*above*	,, ,,
,, 1936 . . .	53	3,	98 ,, 2 ,,	*below*	,, ,,

The individual index numbers, therefore, represent simple percentages of the average point. The 45 articles are grouped in six categories. They are shown in detail in Table 5.

The general average is drawn from all 45 descriptions, which are treated as of equal value, and is the simple arithmetic mean.

Table 1

Construction of Index Number for 1953

1867–77 = 100

	Number of Commodities in Index	*Total Numbers*		*Index for* 1953
		1867–77	1953	
General average	45	4,500	16,558	366
Food	19	1,900	6,184	325
Vegetable food . . .	8	800	2,922	365
Animal food	7	700	2,217	317
Sugar, coffee and tea . . .	4	400	1,045	261
Materials	26	2,600	10,374	399
Minerals	7	700	3,314	473
Textiles	8	800	3,442	430
Sundry materials . . .	11	1,100	3,618	329

Table 2

Annual and Monthly Index Numbers

1867–77 = 100

	Year	*Jan.*	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
1902–1911 .	74	73·9	74·0	74·2	74·5	74·9	74·5	74·5	74·3	74·3	74·5	74·4	74·8
1912–1921 .	148	145·2	146·3	146·9	147·7	147·9	147·2	147·9	149·2	149·0	149·3	149·1	149·2
1922–1931 .	120	122·7	123·0	122·5	122·0	121·0	119·3	119·0	118·0	118·0	118·6	119·2	118·5
1932–1941 .	97	96·0	96·5	96·5	96·8	97·3	96·9	97·5	97·8	98·7	98·8	99·4	101·4
1942–1951 .	231	221·4	224·1	224·6	227·3	228·0	227·1	226·7	227·3	231·2	235·3	238·5	241·2
1943 . .	155	153·3	153·2	154·0	154·9	155·6	155·4	156·0	154·4	154·6	153·7	153·9	153·9
1944 . .	160	154·9	155·1	155·7	157·9	159·5	160·0	161·9	161·5	160·1	159·6	160·3	160·7
1945 . .	164	161·4	161·5	162·1	162·4	164·0	166·7	165·2	163·2	162·7	162·7	162·7	163·2
1946 . .	186	165·6	166·2	166·6	168·4	169·3	169·7	174·4	175·7	180·5	196·2	198·1	200·5
1947 . .	230	206·7	209·6	212·1	215·9	216·5	218·1	223·4	225·9	228·9	236·0	240·8	246·5
1948 . .	260	250·5	253·4	256·0	256·4	260·0	263·9	260·4	260·1	258·1	261·5	263·8	266·0
1949 . .	274	267·6	266·8	265·4	272·0	269·2	267·2	263·3	262·5	285·7	291·5	293·7	297·4
1950 . .	324	300·2	301·0	301·7	305·2	308·3	310·3	317·7	332·1	335·7	349·2	363·1	372·3
1951 . .	402	404·8	420·5	419·3	425·7	420·6	405·2	394·5	387·9	395·9	392·0	396·9	399·7
1952 . .	380	403·5	394·8	384·4	377·5	372·2	379·5	374·4	370·4	369·9	368·9	369·4	372·9
1953 . .	366	374·5	375·2	374·9	370·3	368·1	367·5	361·3	357·9	357·0	357·3	357·7	360·0

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Annual and Quarterly Index Numbers for Groups

1867–1877 = 100

	All Groups	Food				Materials			
		Total	Vegetable Food	Animal Food	Sugar, Coffee and tea	Total	Minerals	Textiles	Sundry Materials
1902–1911	74	71	66	88	49	77	90	70	74
1912–1921	148	146	136	167	100	154	166	151	148
1922–1931	120	115	101	150	80	122	137	128	110
1932–1941	97	88	84	116	49	103	131	94	91
1942–1951	231	172	201	169	121	273	300	306	232
1943	155	138	156	156	72	167	187	166	156
1944	160	137	152	156	73	178	197	182	161
1945	164	139	155	156	78	182	209	189	159
1946	186	140	155	154	88	219	239	231	198
1947	230	156	191	149	100	284	304	295	263
1948	260	171	217	155	107	324	368	348	279
1949	274	201	240	185	151	328	382	356	273
1950	324	235	268	204	224	390	416	491	299
1951	402	265	305	227	249	502	516	639	394
1952	380	294	336	285	227	443	532	475	363
1953									
1952 1st Quarter	394·2	284·0	324·7	259·7	244·2	475·3	550·0	523·9	392·6
2nd ,,	376·4	283·9	323·7	273·4	225·3	444·6	535·6	477·3	362·9
3rd ,,	371·6	293·6	322·5	300·8	226·3	428·6	536·2	448·4	345·9
4th ,,	370·4	302·6	332·9	313·5	225·5	420·1	513·2	441·8	344·9
1953 1st Quarter	374·9	319·8	372·9	314·6	226·5	415·1	510·6	431·4	342·3
2nd ,,	368.6	331·1	380·9	317·0	250·0	396·0	464·7	430·5	327·3
3rd ,,	358·7	319·2	353·0	317·6	251·9	387·7	453·7	426·8	317·1
4th ,,	358·3	318·7	348·9	315·4	264·4	387·3	459·8	428·8	311·1

TABLE 4

Monthly Index Numbers for Groups

1867–1877 = 100

	Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952													
Food:													
Total	294	285·9	282·9	283·1	280·1	277·7	294·0	290·5	293·9	296·3	300·1	302·8	304·8
Vegetable food	336	324·8	323·4	325·8	324·2	321·4	325·6	316·4	323·5	327·7	329·2	332·6	336·9
Animal food	285	259·7	259·7	259·7	259·7	259·7	300·8	300·8	300·8	300·8	313·5	313·5	313·5
Sugar, tea and coffee	227	251·1	243·4	238·1	228·5	223·4	224·0	225·2	225·2	228·5	221·3	227·2	227·9
Materials:													
Total	443	489·6	477·6	458·8	449·5	442·2	442·1	435·7	426·4	423·8	419·3	418·2	422·8
Minerals	532	540·9	558·3	550·7	543·3	523·0	540·4	539·5	533·5	535·5	509·2	509·3	521·1
Textiles	475	563·5	519·7	488·5	477·9	479·8	474·2	461·4	441·5	442·3	445·1	443·3	437·0
Sundry	363	403·4	395·6	378·7	369·3	363·4	356·1	351·1	347·2	339·3	343·2	341·9	349·7
1953													
Food:													
Total	325	318·1	321·9	319·4	329·8	330·3	333·1	324·4	315·5	317·6	317·3	317·7	321·1
Vegetable food	365	372·7	377·3	368·6	378·5	378·8	385·4	365·3	346·9	346·9	346·1	348·7	351·9
Animal food	317	313·5	314·7	315·7	316·4	317·0	317·5	317·6	317·6	317·7	315·4	315·4	315·4
Sugar, tea and coffee	261	219·6	227·1	232·9	249·8	250·2	250·0	249·8	248·9	257·1	263·1	260·6	269·4
Materials:													
Total	399	415·8	414·1	415·5	399·9	395·6	392·6	388·3	388·9	385·8	386·6	386·7	388·6
Minerals	473	515·7	508·5	507·7	464·5	464·6	465·1	453·5	453·8	453·9	460·3	458·7	460·4
Textiles	430	430·4	431·5	433·2	432·5	430·8	428·2	427·1	432·7	420·6	424·8	428·1	433·5
Sundry	329	341·6	341·5	344·0	335·2	326·2	320·6	318·5	315·8	317·0	312·0	311·0	310·3

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 5

Average Prices of Each of the 45 Commodities

1949 to 1953

		Average Prices					Index Numbers (1866–77 = 100)				
		1949	1950	1951	1952	1953	1949	1950	1951	1952	1953
Vegetable Food											
1 Wheat, English Gazette	*s.* and *d.* per qr.	99 6	110 8	122 10	129 0	138 0	183	203	225	237	253
2 American	,, ,, ,,	88 3	107 9	106 0	108 11	112 5	158	192	189	194	200
3 Flour, G.R.	*s.* per sack (280 lb.)	43½	52	56⅜	80¾	102⅓	95	113	123	175	222
4 Barley, English Gazette	*s.* and *d.* per qr.	92 4	99 8	124 6	116 4	102 4	237	255	319	300	275
5 Oats, ,, ,,	,, ,, ,,	58 6	60 2	72 11	74 5	68 0	225	231	280	286	262
6 Maize, American mixed (*a*)	*s.* per qr.	72½	105½	127⅛	132¼	122⅓	223	325	391	407	376
7 Potatoes, good English	,, ton	222	225	261	295	300	190	192	223	252	257
8 Rice, Rangoon cargoes to arrive	*s.* and *d.* per cwt.	61 0	63 0	69 0	83 6	107 9	610	630	690	835	1077
Animal Food											
9 Beef, prime	*d.* per 8 lb.	103¼	114	125½	158	176	175	193	213	268	300
10 ,, 2nd quality	,, ,,	88⅝	96	107½	140	150	177	192	215	280	300
11 Mutton, prime	,, ,,	127¾	140	152½	190	208	203	222	242	301	330
12 ,, 2nd quality	,, ,,	92 1/16	98	100	111	113	169	178	182	202	206
13 Pork, large and small, average	,, ,,	127⅜	140	152⅜	190	202	245	269	293	365	389
14 Bacon	*s.* per cwt.	159½	175¾	194	281½	339	216	238	262	380	458
15 Butter	,, ,,	134⅛	168¼	230½	250	292½	107	135	184	200	234
Sugar, Coffee and Tea											
16 Sugar, Java floating cargoes (*b*)	,, ,,	26¼	40⅜	45⅜	33	26 5/16	92	142	159	116	94
17 ,, Continental whites	,, ,,	,,	,,	,,	,,	36¼	,,	,,	,,	,,	157
18 Coffee, Ceylon plantation, low middling (*c*)	,, ,,	356	532	520½	471½	448⅜	409	611	598	542	516
Rio, good	,, ,,	145	297¼	395	380	387	227	464	617	594	604
19 Tea, average import price	*d.* per lb.	33·72	37·37	39·42	38·36	40·03	195	217	228	222	234
Minerals											
20 Iron, Scottish pig	*s.* and *d.* per ton	228 11	239 6	252·1	291 10	328 9	} 336	348	367	424	468
Cleveland (Middlesborough) pig	,, ,, ,,	204 7	209 1	221·10	255 8	274 10					
21 bars, common	£ per ton	20	20	21⅞	26⅕	28⅜	244	244	263	325	344
22 Copper, Standard	,, ,,	132¾	179	220⅝	260	254⅛	177	239	294	347	340
23 Tin, Straits	,, ,,	603½	744 1/20	1,073⅞	964 5/16	721 7/16	575	709	1,023	919	687
24 Lead, English pig	,, ,,	104 1/16	111 5/16	163 9/16	135 9/16	91 3/16	508	543	798	661	447
25 Coal, Best Yorkshire House	*s.* per ton	54¾	53	58½	64 1/2	69½	249	241	266	296	316
26 average export price	,, ,,	72·97	73·65	74·88	94·38	89·03	584	589	599	755	712

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5—*cont.*

			Average Prices					*Index Numbers* (1866–77 = 100)				
			1949	1950	1951	1952	1953	1949	1950	1951	1952	1953
Textiles												
27	Cotton, Middling American	*d.* per lb.	24·85	36·15	46·01	38·92	31·83	276	402	511	432	354
28	East Indian	,, ,,	20·52	32·96	42·04	36·93	28·73	304	488	623	547	426
29	Flax, Medium grade continental retted	£ per ton	283¾	351	486	380½	321½	562	689	968	737	628
	Belgian import price	,, ,,	244·3	296·7	424·3	312·3	269·9					
30	Hemp, Manila for roping	,, ,,	105¾	144	183 7/12	130 15/16	125	363	435	547	527	474
	Italian S.B.	,, ,,	117⅞	195 7/12	243½	270¼	244¾					
31	Jute, Daisee ⅔	,, ,,	101½	112 7/16	168⅜	99⅞	79¼	534	593	886	526	417
32	Wool, Merino, Port Philip, average fleece	*d.* per lb.	92⅜	157 7/16	177¼	120	126¼	506	821	912	621	665
	Merino, Adelaide, average greasy	,, ,,	65	98⅛	106½	73	80¾					
33	English Lincoln half hogs	,, ,,	38⅜	65¾	99	49½	60	194	333	501	251	304
34	Silk, Japanese	*s.* per lb.	25¼	38 5/16	37⅛	36⅔	40	110	166	162	160	174
Sundry Materials												
35	Hides, River Plate, dry	*d.* per lb.	21 15/16	28 1/16	42¼	25¼	22 15/16	279	360	558	336	309
	River Plate, salted	,, ,,	20 7/16	26 13/16	38 1/16	20 5/16	20¼					
	average import price	,, ,,	21·43	27·08	47·27	30·95	27·47					
36	Leather, dressing hides	,, ,,	45	58	80¾	62½	57	328	373	516	388	380
	average import price	,, ,,	69 1/16	71 11/16	98 5/16	72½	75¼					
	Tallow, Town	*s.* per cwt.	60	80⅛	109 5/16	86½	66¾	133	178	243	192	148
	Oil, palm	£ per ton	99¼	100 3/16	108⅝	106⅛	83	254	257	278	272	213
	olive	,, ,,	320	322	387	328¾	305⅜	640	644	774	657	611
	linseed	,, ,,	149⅝	132 7/16	169	185	180	385	417	522	508	443
	Seeds, linseed	*s.* per qr.	197	243¼	301⅛	272	209¼					
41	Petroleum, motor spirit (c.i.f.)	*d.* per imp. gall.	9·61	11·67	12·66	13·30	12·32	60	73	80	84	77
	Kerosene (burning oil) c.i.f.	,, ,, ,,	8·51	10·55	11·41	12·58	11·36	135	167	181	199	180
	gas oil, c.i.f.	,, ,, ,,	7·78	9·84	11·19	11·84	10·76	195	247	281	297	270
42	Soda, crystals	*s.* per ton	107½	107½	125	190	190	117	117	136	206	206
43	Sodium nitrate	*s.* per cwt.	20½	21¾	27⅜	30	29¾	146	155	195	214	212
44	Indigo, Bengal, good consuming	*s.* per lb.	7	7	9⅛	14	12½	97	97	126	193	172
45	Timber, hewn, average import price	*s.* per load	207·09	228·33	367·83	376·00	374·64	493	534	806	829	758
	sawn, or split, average import price	,, ,,	354·37	380·46	550·31	569·24	489·49					

(*a*) Argentine maize (Feeding Stuffs) from 1941. (*b*) Raw centrifugals. 96 per cent. Pol,. from 1924. (*c*) East India, good middling from 1908–1947; Kenya from 1948.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 6

Index of Silver Prices

The base of the Index Numbers given below is 60·84*d.* per standard ounce = 100, this being a parity of 1 fine oz. of gold to 15½ standard ozs. of silver.

	Price per oz. Standard (d.)		*Index Number*	
	Average for year	*At end of December*	*Year*	*At end of December*
1942	23½	23½	18·1	18·1
1943	23½	23½	18·1	18·1
1944	23½	23½	18·1	18·1
1945	30½	44	23·1	31·1
1946	48⅝	55½	36·7	41·6
1947	44 7/16	45	33·3	33·8
1948	45	42½	34·1	31·9
1949	49⅛	64	32·8	33·3
1950	64¼	70	33·7	36·4
1951	77 27/32	77	40·5	40·1
1952	74⅜	72¾	38·7	37·9
1953	73 15/16	73¾	38·5	38·5

TABLE 7

Gold and Silver: Production

	Gold Value of output (£ *thousand*)	*Silver* (*million ounces*)				
		Total	*United States*	*Mexico*	*Canada*	*Australia*	*Other Countries*
1932–1941	2,415,123	2,334·2	524·6	766·9	204·2	838·5	
1942–1951	2,847,643	—	376·2	563·0	176·4	—	
1942	289,153	..	54·5	84·9	21·8	71·8†	
1943	226,397	..	44·8	71·2	18·6	59·3	
1944	209,031	..	37·4	63·0	14·8	57·7	
1945	199,116	..	29·3	61·1	14·0	46·4	
1946	202,435	..	21·4	48·3	13·6	47·1	
1947	206,434	..	36·1	49·2	13·5	44·6	
1948	214,647	..	36·1	45·8	17·0	46·0	
1949	320,887	..	34·6	49·5	17·6	44·3	
1950	329,580	..	42·0	49·0	22·5	44·2	
1951	322,623	..	40·0	43·8	23·1	39·8	
1952	329,381	..	40·2	50·3	25·2	41·7	
1953*	328,600	.	35·0	45·0	30·0	43·5	

* Provisional. † Incomplete from 1942 onwards.

(a) Argentine maize (Feeding Stuffs) from 1941. (b) Raw centrifugals. 96 per cent. Pol., from 1924. (c) East India, good middling from 1908–1947; Kenya from 1948.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Nature and Sources of Statistics in Special Fields of Statistics

Medicine and Medical Services in the United Kingdom

By B. Benjamin, B.Sc., F.I.A.

*Statistician, General Register Office**

Introduction

Modern medicine as a therapeutic science is sustained in its practice by a powerful industrial and administrative organization. It is inherent in the nature of medicine that the relationship between doctor and patient, should retain all the individuality and humanity that is embodied in the Hippocratic tradition; but in the bringing together of the sick person and the healing physician and the furnishing of all the diagnostic and curative services which lie at the physician's command a large scale organization is constantly moving. It is difficult to disentangle the two threads of purpose; the science and the practice; the study of disease and the study of administration. So, in a survey of applied statistics in medicine and medical services we find that some of the statistics are essentially medical; some are essentially administrative, i.e., only medical in so far as they deal with medical services, and not unlike the statistics of administration in other spheres of human activity; and some are a mixture of both these aspects. We must continually keep in mind the two approaches; statistics of clinical medicine—measurement of the nature of or the reactions of those to whom medical services are administered; statistics of administration—measurement of needs, of services, of materials, of persons and of success or failure in meeting needs.

Statistics in Medicine

The statistical method is essential to medicine; it involves the processes of comparison, classification, analysis and differentiation, which are inherent in medical thought and practice. For medicine itself is a craft derived from centuries of experience and the acquirement of skill is dependent upon the assimilation of summarised experience. Consciously or unconsciously the teaching of medicine and its practice call for the sifting of a myriad of facts by those very processes of classification and association upon which the statistical method is founded. For the statistical method is no more, and no less, than the application of logic to observation. The statistical processes ought to be the constant servants of the medical practitioner. In research, too, advance frequently rests upon the statistical theory of design of experiment and of the analysis of variations between experimental groups and few advances in techniques of diagnosis or treatment can be made without statistical methods.

Curiously, it is mainly in laboratory research that the value of statistics is patent and unquestioned. Doubtless the explicit use of mathematical symbols and of actual numbers advertises the contribution of the statistician. Yet the descriptive art of a master of observation such as Sydenham and the comparative methods of the early epidemiologists in their small but vitally important field studies involved the discipline of the mathematical mind. Even the general practitioner of to-day counts the frequency of symptoms, though perhaps seldom consciously. When it is said that it is usual for such and such a set of symptoms to arise from infection with a particular organism or with the development of a particular type of tumour, in fact, whenever a clinical entity is recognized, a statistical inference has been made. Only to the extent that it is made objectively and consciously is it likely to be trustworthy.

To assess the diagnostic value of a symptom involves the study of its frequency in the healthy as well as the unhealthy. Ryle (1947) has emphasized that "in consequence of the neglect of the study of 'healthy' populations and of what may best be described as 'normal variability' a number

* The views expressed in this paper are personal and not necessarily those of the General Register Office.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of physical findings due to clinical and associated methods have been accounted abnormal (in the sense of pathological) with quite inadequate justification and often for too long periods. Inaccurate diagnosis, faulty treatment and unnecessary invalidism have again and again been traced to this failure in essential discipline". Ryle's thesis is rich in illustration. "Had such . . . (statistical) . . . studies been undertaken in the past it is unlikely that we should have witnessed the frequent faults of interpretation accompanying new diagnostic methods; the sorry manufacture of cardiac and 'blood pressure' invalids; the widespread craze for tonsillectomy and other 'trial and error' operations; the anxieties dependent upon such diagnoses as hilar tuberculosis; the wrong attribution and delayed treatment of some postural defects; and the general neglect of comprehensive aetiological inquiry, which have together marked the last three or four decades of medicine and stayed its rational advance".

In pharmacology and therapeutics statistical methods have long been accepted as indispensable. In the determination of optimum dosage of drugs experimentation is essential and since such experimentation is time and money consuming there is a need for the most economical techniques to be employed—as much information as possible must be extracted from as few tests as possible. A number of special techniques have been evolved: for example probit analysis (Finney, 1947). In the long-term follow-up of cancer and tuberculosis in order to assess the relative effects of various kinds of treatment on the survival experience of groups of defined prognostic characteristics, actuarial methods have become a routine. If comparisons are to be valid great care in the application of these methods is essential and in relation to cancer the W.H.O. have recently found it necessary to lay down minimum requirements. The important considerations are the standard definition of prognostic factors such as stage of disease, the possible selective nature of the statistical material, e.g., the elimination of "bad risks" under some pretext such as failure on retrospective examination to come within stage or treatment definitions although originally so accepted, or the changed character of the population owing to the fact that the follow-up itself has been selective by making it more likely that one type of patient than another will be traced. Death from intercurrent non-cancerous disease needs to be treated in an agreed manner. Most important, not only in relation to cancer, but in the assessment of treatment of all disease, it is necessary to have "control" groups of adequate size and representation. If a certain treatment appears to produce beneficial effects are we sure that these effects would not have occurred without any treatment at all? "Cures" are accepted or rejected not on absolute effects but on relative effects. The requirements of a control group are simple. We must compare like with like and the controls must match a cross-section of the treated; but failure to recognize this simple requirement has in the past led to unjustifiable claims being made without sound foundation.

In surgery the case for statistics has been well made by Sir Max Page (1947). From an address full of illustrations two may be quoted: ". . . the most striking feature (in gastric surgery) was the prolonged popularity of some type of short-circuit operation of pyloric and duodenal ulcer. The want of knowledge of the frequent failure of this procedure, when it had been applied to stomachs without obstruction and with high acid must be attributed to a defective follow-up"; and again: "A more definite example of the lack of guidance from proper records is to be observed in the assessment of the value of hernia operations. For thirty years or more after Bassini's method and its various modifications had been widely accepted almost any surgeon . . . would express the opinion that there was hardly any recurrence after his own operations. Yet an independent investigation of some 300 cases undertaken in 1934 by Barrett and myself showed that the recurrence rate for inguinal hernia occurring in the Metropolitan Police was over 20 per cent". Sir Max Page sums up by saying: "In the course of its rapid development, modern surgery has been over-dependent on judgments tinctured by the emotional reaction common to mankind and . . . it has largely failed to utilise statistical research".

In preventive medicine statistics have had strong advocates since the days of Graunt and Farr and the early epidemiologists. The statistical method, as a result of their influence, has become an essential part of the equipment of the medical officer of health. The public health authority must continuously examine the problem with which it has to cope and adapt its resources to the changing objectives and needs. This involves a study of population statistics, of mortality and morbidity analyses and of the statistical aspects of epidemiology. The field is wide and methods of documentation are varied. The chief requirement is that the medical officer should know the available

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

sources (for example, the principal content of the publications of the Registrar-General) and understand the indices calculated and disease classification used. It is important that, since the medical officer of health either consumes or helps to initiate a large and varied number of records covering every aspect of the public health service from disease notification to school medical inspection findings, he should be able to recognize the statistical value of these records and the use to which they might be put either to assess morbidity or, equally important, to assess the efficacy of preventive measures.

No statistical work of value can be achieved except upon the basis of reliable and complete clinical records. Statistical analysis can rarely detect but will merely reproduce errors in the medical record. Workmanlike documentation of conditions and therapeutic procedures is therefore an essential prerequisite of all quantitative study in medicine.

Administration and the Need for Statistics

The task of the administrator is to design and co-ordinate manifold services to achieve a specific social objective with the minimum absorption of collective human effort. This is true of all social organization whether it be ship-building or large-scale agriculture or education or the health service. However, before the administrator can bring the complex resources to meet the complex need, both complexes must be examined and separated into component elements. Each element of need must be matched by a scientifically designed function or element of service. These functions may then be pieced together to form a coherent organization. Analysis must always precede synthesis. Both the precision of the design of the functions and the coherence of the organization are essential to efficiency.

It would profit administrators to interest themselves in elementary statistical methods; to encourage the statisticians to perfect methods particularly applicable to administrative ends; to learn themselves to recognize problems which are peculiarly statistical, i.e., to know when to consult the statistician; and to practice statistical judgment objectively, that is to do consciously what many now do intuitively.

These short remarks about administration are vitally important. The British Health Services cost more than £450 million a year—4 per cent. of the national income—and upon the shoulders of administrators rests a tremendous responsibility to achieve such a high level of efficiency that this cost remains of manageable dimensions and does not grow to such proportions that the very health of society which it seeks to protect is threatened by the economic burden it imposes.

In the wider sphere of planning we remind ourselves that the health industry must be fitted into the whole industrial order of society. Winslow (1951) remarks that the health administrator "must sit down with experts on agriculture, on industry, on economics and on education and integrate his specific health programme as a part of a large total programme of social reconstruction". This applies equally to local and national programmes.

It is proposed now to consider in more detail the various fields of application touched upon in this rapid survey.

Vital Statistics

The observation of community health goes back for three hundred years to the study of bills of mortality by Graunt (Greenwood, 1948). The growth of urban communities which accompanied industrialization and the early inimical conditions of factory life encouraged pestilence and disease and wastage of life. As man's conscience, not to say fear, reacted to these problems with means of preventing disease so it became necessary not only later to measure their effect but first to impress upon a frequently reluctant government the need for their introduction. The analysis of death records and the measurement of related populations, from the time of Farr, became the tools of progress in social hygiene, the stock-in-trade of the medical officers of health. It was left to Newsholme, one time Medical Officer of the Local Government Board (1889) to rationalize the methods and present them for the assimilation of countless successors. The following review of these methods is related to local rather than national statistics in order to facilitate reference to local health authority matters, but there is no essential difference between local and national vital statistics.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Population

It is a truism that in preventive medicine we must know what to prevent and where it is that the danger lies. We have to assess certain risks (their present values and trends) which are usually specific to a particular section of the population. The particular attribute which renders a certain group within the general population more or less susceptible to a disease may be one of many—birthplace, age, sex, occupation, housing or other social factors. Common examples are the low resistance to tubercle of immigrants from rural Ireland, the age incidence of cancer, the higher mortality from peptic ulcer in men as compared with women, the higher incidence of diabetes in grocers, the correlation of tuberculosis morbidity with social conditions. Demographic information is accurately obtained only at census dates. Yet we know that the distributions of almost all the factors which have been mentioned are constantly changing. In recent years there has been violent movement in fertility and large fluctuation even in mortality; there have been major changes in the pattern of industry; and during and after the holocaust much variation in housing conditions. Means have to be found to estimate within as narrow limits as possible, these changes.

The Registrar General provides regular estimates of the overall size of local populations. This at least is something on which to build. We then have to assess the extent to which the distribution by age, sex and other factors differ from the last local census or from such current national estimates as are available. To do this accurately would require a local census and on a sampling basis this is a practical proposition.

An excellent example of the sampling method is provided by the social survey carried out by Grundy and Titmus and others in Luton in 1945. A simple demographic questionnaire was completed, at personal interview, by members of the W.V.S. in respect of every house in areas of unfit houses, one house in five in older parts of the town and one house in ten in the rest of the borough (these areas being separately coded). These questionnaires which were analysed on punched cards (covering over 16,000 individuals), gave up-to-date information *inter alia* of housing conditions, age and sex, marital condition, birthplace, duration of residence in Luton, occupation, education (of school children) and fertility. Not only was a completely detailed picture of the local population obtained, but as a by-product valuable material relating to fertility trends was subsequently analysed (Grundy and Titmus, 1946). The cost was small.

It might, however, be claimed that in normal times when decennial census tabulations are available intercensal changes may be estimated from past trends. If migration can be estimated from local housing records, electoral registers or other sources, then the age and sex distribution can be projected from the last census data by having regard to births and deaths (by age) in the intervening period. Even more approximate methods may be employed if national distributions are available.

Local experience is essential, together with an appreciation of information which comes from local surveys, however small. For example, the London County Council made a family accommodation survey in 1950, that is a survey of the average number of rooms occupied by families with children. The information was required to assist the Architect in the preparation of the Development Plan. It was made by the simple process of taking a random one in 20 sample of health visitors' records which cover over 90 per cent. of such families. It was found that over the county as a whole the average family with children consisted of 2·19 persons over 18 and 2·18 persons under 18 and their average accommodation was 3·04 rooms. A great deal of information was discovered about the relative frequency of different types of dwellings and different sizes of families. The figures have since been confirmed by the 1951 census 1 per cent. sample tables. The survey cost little since no extra staff were employed. (Daley, 1952.)

The Measurement of Morbidity

In preventive medicine we are concerned with the prevalence of morbid conditions, with the aetiology of disease and especially with signs of incipient deviation from normality.

Sickness and health are, however, antitheses and are difficult to define except in terms of each other. A morbid condition is a departure from the normal healthy condition and the overall incidence of disease can only be measured given adequate and practical criteria for defining departure from normality.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

As Stocks (1949) has said "the distinction between living and dead is clear cut, but no such frontier line between sickness and health can be said to exist except in the case of acute illness caused immediately and directly by an external agent. There is a zone between the two states in which the decision whether the subject is sick or not depends on definitions or standards of good health, and also on who decides. It is often said that only a physician is competent to decide what a patient is suffering from; but the patient often has to decide whether or not he is ill at all. If he believes himself to be ill, then he is not in normal health; he is consciously suffering from something and therefore sick. On the other hand a person may think he is well, but on examination for some purpose such as life insurance or by mass radiography it is discovered that he has a disease which may at any time cause disability. From that moment he begins usually to suffer inconvenience, if not actual symptoms and then comes into the category of persons who are sick". Following this line of thought Stocks suggests that "from the standpoint of statistics or morbidity it seems most convenient to define the starting point of illness as the point at which either (*a*) the subject began to be conscious of symptoms or some disability, or (*b*) someone else decided that disease was present of a nature which could not continue to be ignored without danger to the patient". (Class V below.) Early states of disease, *if discovered*, would be included even though the subjects were not conscious of them, but entirely unsuspected disease (e.g., unsuspected cancer or tuberculosis) would be excluded as also would infectious diseases during their incubation periods.

Stocks suggests that the population might be classified as follows:

I. Healthy, i.e., free from any defect.

II. Healthy apart from a congenital defect producing no appreciable disability.

III. Carrying scars or deformities left by past illness or injury, which do not now cause appreciable disability.

IV. Affected by latent or early disease not yet causing the subject to suffer either symptoms of illness or appreciable restriction of activities imposed by its discovery.

V. Ill (sick) as defined above.

A further difficulty arises in that there are a number of different possible measures of sickness. Illness is a condition which continues for a period of time. We may, therefore, consider how many sickness periods (illnesses) *began* in a specified interval, or how many were experienced *at any time* during the interval, or how many were being experienced at a specified point of time, or how many sickness periods were begun or terminated during the interval. We have also to distinguish between persons and illnesses remembering that a person can have more than one illness within the interval. An illness may be a new disease or a recurrence of a disease experienced previously; it may be a new illness beginning in the interval or a continued illness from a previous interval. Agreement upon the best units to use is not general, but it must be emphasized that figures should never be quoted without careful definition of their constitution in the light of these possible sources of confusion.

Rarely is sickness capable of direct and total measurement. The personal observation of individuals involved is difficult and expensive to contrive. It is so often found necessary to be content with indices related to the more exact measures which are impossible of attainment. For example, it would be difficult to assess the total volume of dental caries in the population in successive periods of time; it may be easier to count the number of persons seeking treatment and to use this figure as a guide to the trend in incidence.

In considering the health indices to be used the need for a critical approach should be emphasized. The choice of indices has, in the past been so restricted that, in order to obtain any information at all, it has been necessary to accept, without being critical, such indices as can be easily calculated from routine vital statistics, e.g., infant mortality or the general death-rate, or those which are involved in the administration of particular statutes or regulations, e.g., notifications of infectious disease or attendances at welfare clinics.

The greater attention now paid to record keeping by health workers generally and the development of economical sampling methods is beginning to make it possible for a more constructive approach to be taken. The statistician can, at least, consider asking for *ad hoc* indices which will not suffer from the disadvantages that have, in the past, accompanied expediency, but will, in contrast, have a reasoned clinical foundation, i.e., they will have a clear medical interpretation

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and be in a form that will be properly adapted to statistical treatment. It is worth while to consider which will be the most profitable fields for the statistical measurement of social health.

In the past the study of morbidity has been for the most part limited to the consideration of notifications of infectious diseases and an analysis of causes of death. The first measure has too limited an application to be regarded as a measure of general health, though, as we shall see later, the control of infection depends upon effective reporting procedures. The certificates of death measure only those causes of sickness which may prove fatal—the principal causes of death are not the major causes of disability. Even for illnesses which may prove fatal, mortality statistics are liable to be misleading when the fatality risk is changing, e.g., tuberculosis at the present time.

Where sections of the community are regularly medically examined, the results of these inspections provide useful indices, e.g., statistics of examination of recruits to the Armed Forces might be used, but they would relate only to a narrow age-group and could not be provided on a local basis. The Medical Officer of Health often uses the results of routine school medical inspections as an index of morbidity in children, but, as at present conducted, these are inspections, in the main, of a group of children from whom the relatively unhealthy have already been excluded by absence from school, or by earlier observations of symptoms by the teacher, and the inspections are so limited in time that they discover only the most obvious defects.

Some authorities have begun to analyse the clinical records of patients treated in hospitals and other treatment centres. In so far as this analysis enables the medical officer to exercise a more efficient administration of his resources for the treatment of disease, it is a very necessary part of departmental efficiency, but, as a source of information of morbidity, it may be misleading and its use for this purpose should not be lightly accepted. The disease pattern of a hospital population is liable to change, not because a particular disease becomes more prevalent in the area served by the hospital, but because either a change in medical practice dictates that that disease should be given more hospital treatment than hitherto, or because a particular specialist worker in the hospital asks for more material. There are simpler reasons for discontinuity; for example, at times many patients have had to be treated at home because there were insufficient nurses to staff the available hospital beds. The trend of admissions for a particular disease is often, therefore, quite unrelated to actual variations in incidence. Even the incidence of certain serious illnesses which are never refused admission would be obscured by the variable quantity of not so serious cases which in some years gain admission more easily than in others. The further difficulty arises that it is not possible to say that every case of a particular disease will go to a particular hospital or group of hospitals; thus the exposed-to-risk is not known and absolute numbers must be used and not rates.

In short, hospital statistics have a very high domestic value (for teaching or administrative purposes) but their public health value depends upon the careful examination of the figures and their integration into the complete picture of morbidity including statistics of domiciliary treatment.

Some attempts have been made to measure morbidity, for example that of the Survey of Sickness conducted for the Registrar General of England and Wales, by sampling individual sickness experiences from selected strata of the population. This method represents a real advance in so far as it is an attempt to focus attention on the summation of contemporary variations in the personal health of typical members of the community; it is a real social measure of illness. There is, however, the defect, even when considerably mitigated by the careful methods of control and verification adopted by the Social Survey, who conducted the sampling, that the information as to illness comes from the patient himself, and the patient is not the best observer of his own health of mind and body and of the relationship between them. On the other hand, it is the patient who suffers and what he complains of should not be rejected because it does not conform to accepted medical terminology; rather an effort should be made to interpret and classify the complaints.

Valuable information *could* be obtained accurately and easily by the general practitioners *provided* that the necessary clerical facilities were made available. But the primary duty of the practitioner is to attend the sick and if his fund of knowledge is to be on loan to the communal health services he will need to be convinced first that this can be done without making an additional and unbearable claim on his time and energy. An immediate suggestion, which has been tried, is that use should be made of the certificates which the practitioner already issues as part of the machinery of sickness insurance. The difficulties are: (i) that whilst these records might measure

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the occurrence of new cases of a particular disease, the degree of severity could be assessed only by reference to duration and it may be difficult to dissociate duration of illness from duration of claim; (ii) that the information will be out of date before it becomes accessible to public health workers; this is the most serious difficulty. It is no use taking action about a local epidemic of enteritis months after it has passed. A more comprehensive yet more intimate record is needed. If, shared among a number of medical practitioners so as to spread the burden, weekly records could be kept in the local area of a representative sample of families showing in entirety the morbidity of each member of the family, a reliable and up-to-date morbidity index would emerge. Logan (1953) has given an account of experiments carried out by the Registrar General for England and Wales. Difficulties are presented by the varying standards of diagnosis and the lack of precision in numbers exposed to risk.

Health visitors (Public Health nurses) visit households and report regularly upon the health of the infants within each family visited. These health visitors are highly trained workers—their advice is of great value to parents and their observations are trustworthy. Their records provide for a periodical review of the health of the infant and for correlation with a medical record kept at the local infant welfare centre. When the infant attends school or moves to another area, his medical history goes with him. This is an important contribution, but it is not sufficient for it does not cover adults. In the first place it is too detailed for adults who have ceased to develop. Secondly, the health visitors do not at present normally see the adult members of the family other than the mother and information gained by questioning would be limited to the subjective observations of the mother.

The Home Nursing Service, which forms an integral part of the British Health Service, provides records which may be used as an index of illness for which general practitioners prescribe nursing care, but which cannot or should not be treated in hospital. The nurses deal with a highly selected population heavily weighted with elderly chronic sick, but this in itself lends importance to their records, for no other such specialized information of morbidity in the aged is available. In times of epidemics, for example of influenza, the Home Nursing Service accepts a large part of the nursing care and is in the fore-front of the struggle.

It is probable that records of sickness absences in large public or industrial organizations, if adequately maintained and properly analysed could throw much light on current trends in morbidity (Lloyd and Spratling, 1951). A great deal depends on the manner in which the recording is organized. In many cases the records are furnished to the centre by departmental staffs, it being rarely possible to submit original medical certificates since these are passed elsewhere for insurance and sick pay purposes. In the circumstances the copying of the diagnosis would need to be done intelligently and with some knowledge (at least) of terminology. Skilled medical advice and supervision would be needed in the classification of the absences to groups of diseases. It is doubtful whether the standard of recording has reached this level in more than a very small number of organizations; many attempt a breakdown of sickness records by age and grade of employee, but only rarely are the different diseases classified. There is no doubt that the continuous survey of such records (with due reservations as to their application to certain occupations only) could be of great assistance to health authorities.

This brief review of sources is not exhaustive. Mention might have been made of reports from Ambulance Services, hospital bed bureaux or public health laboratories and the special studies carried out by Student Health Organisations (Bailey, 1951). Ambulance Services and Bed bureaux, for example, have given valuable information on the occurrence of influenza epidemics.

Mortality statistics.—British mortality statistics are among the most reliable in the world, perfected as they have been over the past hundred and fifteen years by William Farr and his successors. Despite their limitations as indices of morbidity, they provide useful indications of growing dangers and the success or failure of public health measures.

There are many hazards in the use of mortality figures. The need for standardization for age and sex when making comparisons between areas or different epochs is important. In making comparison between countries it is necessary to take into account differences in diagnostic and certification practice. For example, the Americans rarely assign a death to bronchitis but prefer to certify pneumonia or cardiovascular disease. Changes in international classification agreements

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

disturb continuity in tabulations, especially in 1940, when the rules of selection in joint causes were abandoned. Deaths from diabetes, for example, were apparently reduced overnight by 30 per cent. Many discontinuities and difficulties of interpretation are removed by studying groups of causes rather than individual causes, e.g., Cardiovascular-renal, i.e., heart and other circulatory; cerebral vascular lesions; nephritis; bronchitis (owing to its frequent concurrence with heart disease and with advanced age); malignant neoplasm; tuberculosis; pneumonia; digestive disease, especially peptic ulcer; diabetes; infant mortality, particularly prematurity, congenital malformation, birth-injury and infection.

The analysis of mortality so often proceeds to the production of single figure indices for comparing the experience of different groups that it is largely an exercise in weighted averages. An account of the various indices with a demonstration of their interrelationship has been given by Cox (1950); this textbook may also be referred to for a discussion of the various axes of comparison. Occupational mortality analyses. for example, are an important segment of the field of medical statistics.

Infectious disease.—Persistent measures of control, health education, bacteriological advances, and a rise in nutritional standards have all contributed to the reduction of mortality from the common infections from a very high to a very low level; but as has been remarked earlier, were it not for continuing communal and individual vigilance, the pestilences which we now regard as conquered could once more return. Therefore, it is important that the number of cases of infectious disease reported daily to the local authority must be closely followed, so that any upward turn may be quickly recognized and the necessary measures of control as quickly instituted.

Local practitioners notify cases to the Medical Officers of Health of County Boroughs Sanitary Districts, who also forward the details to the Medical Officer of Health of the County Council. A weekly analysis is usually made and a review of movements in the numbers is circulated to the medical personnel concerned. Changes of diagnosis in respect of earlier notifications are shown as they come to light. The routine details analysed are: Date of notification; disease; age; sex; place of residence.

The main use of these records (apart from the weekly review of incidence) may be summarized as:

(*a*) Variations of incidence in subdivisions of the area of the local authority. Since those subdivisions will have different social conditions, valuable information may be gained as to the influence of economic factors. (Bradford Hill and Martin, 1949.)

(*b*) Patterns and rapidity of spread throughout the area and the identification of foci.

(*c*) A study in sex or age incidence, changes in which serve as important epidemiological clues. (Benjamin and Gore, 1952)

There are many problems left for the medical epidemiologist and the statistician jointly to tackle. The case-mortality of measles has fallen dramatically, but measles epidemics are nevertheless a heavy burden on doctors and nurses. Can we contrive an adequate warning of their arrival? Owing to wartime disturbance of the child population and other factors yet to be ascertained, the pre-war biennial rhythm has not been followed in post-war years. What sort of rhythm is emerging? (Benjamin and Breen, 1951.) At any instant can an assessment be made of the proportion of the population susceptible to attack? What is the rôle of nutrition; or urbanization? There are similar problems in the epidemiology of whooping-cough. Poliomyelitis engages more of our attention than hitherto. As communities emerge from squalor to high degrees of sanitation their infant population ceases to be protected by the frequent mild immunizing infections of earlier times. A mild endemic disease may now be replaced by periodical explosive outbreaks of a violent and damaging nature. The discovery of an effective method of control is a matter of urgency. Greenwood (1946) listed many more problems, and summarizes—"the riddle of the epidemiological Sphinx is still unread".

The raw material is in the records of local health authorities, and it is for statisticians in concert with their medical advisers to see that no experience is wasted.

The mathematics of epidemic spread and infectivity have been considerably developed, in the earlier classical modes of Kermack and McKendrick (1927 and after) and Soper (1929) and later, from a more practical viewpoint, by Wilson and Worcester in U.S.A. (see, for example, Wilson

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and Worcester, 1945); more recently still Bartlett (1949) and Bailey (1950), have introduced the application of the probability distribution to allow for the operation of chance in the conditions under which infection takes place. Mention must also be made of the classical experimental work in herds of mice by Toplay, Wilson and others (Greenwood et al 1936).

Other Local Authority Statistics

School Health Statistics.—The statistical records of this service are available as a measure of the contemporary health of school children.

At the periodical routine inspections the following information is recorded on the main school medical record card of the pupil:

Name of school.
Age at examination.
Date of examination.
Prophylaxis (whether protected against smallpox, diphtheria).
Vision (Snellen index).
Cleanliness (infestation of head or body).
Condition of teeth.
General condition of pupil (good, fair, bad).
If leaving school, any contra-indications for particular types of occupation.
And the standard list of defect groups specified on the Ministry of Education main school medical record 10M.

In respect of each defect an indication is given of whether the disease is sufficiently severe to require treatment, or whether the condition is mild or likely to clear spontaneously and is merely to be kept under observation. Follow-up examinations are also made and are the subject of statistical analysis.

The trend of illness in the above categories is assessed by the year-to-year comparison of the percentages found (in each age-group) to require treatment or observations for a particular defect, with detailed comparisons for individual defects, individual age and sex groups, and subdivisions of the area.

Treatment.—The statistical aspect of treatment and follow-up is to some extent covered by reinspection records. More analytical statistics of treatment cannot at present be obtained since the contribution of the local authority to treatment is now diminished and the greater part is left to the hospital or to the general practitioner. There is, however, commonly an arrangement by which the hospitals send discharge reports to the school medical officers and these reports, after any necessary action has been taken, form part of the medical history kept for each pupil in the school. It will be possible when the practice is more widespread to cull more information about treatment either on the reinspection card or by direct review of the main school medical record.

Height and weight measurements.—Pupils in some areas are weighed and measured regularly. These measurements are charted on individual records which are kept under review so that action can be taken if there is any abnormality in the growth of the child. Although this is primarily a system of individual observation, some authorities have collected the records in at regular intervals in order to make a mass survey. This not only provides an objective assessment of the nutritional condition of school children but provides a standard pattern or growth. (Tanner, J. W., 1952.)

Maternity and child welfare.—So soon as an infant is born three important records are instituted: (1) the birth register—an index built up from the statutory form of notification under the Public Health Act, 1936; this is not only a birth register but an effective index to the local maternity and child welfare records. (2) The health visitor's record of consultations in the home and at the infant welfare centre. (3) A medical consultation record at the infant welfare clinic. These last two records are complementary to each other, being observation of the same infant from differing standpoints of the health visitor and the clinic doctor. The records are sometimes arranged to dovetail into the Ministry of Education school medical record (referred to above) in which they are filed when the child enters school. Comprehensive medical recording from birth to school-leaving age may be thus an accomplished fact.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In respect of the maternity service much valuable material is provided by the medical records kept in the ante-natal clinics and by the case records of the domiciliary midwives. These provide data for observing trends in fertility and maternal morbidity and for testing the efficiency of the medical service. The ante-natal clinic record not only contains provision for post-natal examination but it may have filed with it either the case record of the domiciliary midwife (if a home confinement) or a discharge report from the maternity hospital; thus becoming a complete account of pregnancy and childbirth. Periodical reviews are made of all these records. Especially has their statistical utilization been efficiently developed in Birmingham (Charles, 1951). An early study of infant weight records in London by Gore and Palmer has been much quoted.

Apart from these clinical records the health visitor keeps a daily record of her visits and of centre activity which is summarized and effective registers of centre attendances are maintained.

Home nursing.—In addition to collecting statistics of activity, new cases treated, old cases discharged and total visits month by month, it is possible to analyse completed treatments in suitable periods by age, sex, diagnosis, total visits and duration of treatment. However incomplete, this does form a contribution to measurements of illness treated at home and especially of chronic invalidism in the elderly (Wofinden & Emblem, 1952).

Domestic help service.—Records of work done are carefully maintained and reviewed. The cases may be analysed to show, for each category of case, maternity, tuberculosis and general illness—the total case-load at a given date, together with details of staff and throughout the period of review:

Number of new applications received.
Number of cases in which service commenced or recommenced.
Number of applications refused or deferred because of
(*a*) inability to supply,
(*b*) other reasons.
Number of cases in which service was completed.
Number of visits paid by supervisors.

The aged in their own homes.—The proportion of old people in the population is rising and health services face a growing burden of degenerative disease and of geriatric care. It is from surveys of home nursing and domestic help services that valuable information is obtained of the scope of this problem (Chalke and Benjamin, 1953).

Prophylaxis.—Registers in card-index form are kept of all immunizations carried out. These cards are of the standard form recommended by the Ministry of Health. Without such registers, classified by year of birth and inoculations given, it would be impossible to assess the current extent to which the child population have been protected against smallpox, diphtheria or whooping-cough.

Administration.—Information collected by the statistical service of a local health authority is of three types:

(1) Medical intelligence, e.g., incidence of infectious disease, or analyses of mortality statistics by cause. The medical staff require this information for day-to-day administration.

(2) Statistics of activity, e.g., attendances at clinics or immunizations carried out. These statistics are of value to administrative and professional staff and are communicated to the Health Committee of the authority.

(3) Special studies. These may take the form of a clinical trial (Breen and Benjamin, 1950) or of social factors in the aetiology of a disease such as tuberculosis (Benjamin, 1953) or particular problems in local supervision of infants (Stewart and Russell, 1952).

Future trends.—In the days of widespread outbreaks of fever, the great statistical need was a system of prompt and complete reporting of the occurrence of symptoms of infection, usually of sudden onset and sharply defined. Infectious disease notification was born of this need. Already the high fatality and the pressure of other vital statistical and economic problems had given us a system of death registration. Later the need to institute infant welfare at an early stage led to a

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

system of birth reporting. Later still came tuberculosis notification both for new cases and for hospital movements. The accent was on the occurrence of an incident.

In modern times we are not so much concerned with sudden happenings as with insidious development of abnormality or the slow onset of degenerative disease. New statistical techniques are called for. First we need a type of record that indicates the health of an individual, not as a snapshot, but as a moving picture, a continuous and complete sequential record of day-by-day, year-by-year observation. A beginning has been made with pre-school and school children. The same principle could be extended to adults. To be complete and continuous the record need not be elaborate. A few well-chosen criteria by which to judge progress are better than a drag-net which gathers in unwanted as well as essential detail. An elaborate record may be necessary for a specialized study of limited duration, but if used for routine purposes it will not survive beyond the short initial period of novelty and enthusiasm. After a time it gathers more than can be digested. It is not wholly used and so there is no drive to make it complete. It begins to fall into partial disuse. But one thing is certain. These new records must be more complex than those of former times, and we must allow field-workers time or clerical assistance to complete them.

A second problem is that of extracting information from the records. If these records are to do their job they should be constantly available to the field-worker, and it is not a good thing to remove them to a statistical office for processing. This means that an additional document has to be used as a carrier of information between the primary record and the statistical office. The transcription sheet can either be completed by the field-worker or by trained staff with access to the records. Sampling by properly arranged random selection in order to reduce the number of units of information to the smallest number compatible with reliable results is likely to be more generally adopted in future to reduce the volume of records to be handled.

Research.—Many problems remain to be solved. How can we control tuberculosis, for example, unless we make an all-out effort to trace every infectious case? Even of the ascertained cases of tubercle we do not know enough of their disposition in space, their potentiality for infecting others through occupational contact or inferior housing conditions. We do not know enough of the fate of contacts. Tuberculosis clinic records are too much neglected, but fewer cases are dying and more are surviving and the supervision of infectious, though happily less fatal, cases becomes a problem of growing magnitude. Many other examples could be quoted.

More important than such specific problems is the greater problem of the planning, as distinct from the haphazard development, of personal health services. Local authorities ought to engage in "market research" on the needs of their customers. Objective examination is needed of the available data to decide what is good for the customers. Expert opinion based upon mere impressions does not make for good government. What *kind* of work, for example, is done in the various types of clinics. Job analyses are required in order to find out what part these clinics are playing in the life of the community (George, Lowe and McKeown, 1953) and whether they fall short of the needs of the people. A declining death-rate is not always convincing evidence of the efficiency of a service. Functional enquiries are an important contribution to wise administration.

Most special statistical studies are therefore directed to either (1) discovering what is preventable, e.g., special studies of infantile enteritis (Scott, 1953); (2) testing the efficiency of measures, e.g., whooping-cough immunization; (3) finding out what officials are doing, e.g., a job analysis of school nurses was recently carried out by the London County Council; (4) finding out what the public need, e.g., what are the defects of the home help service (Chalke & Benjamin, 1953); what is needed in health education (David, 1952).

A social service cannot operate efficiently without making a continuous study both of the communal needs which it attempts to satisfy and of the effectiveness of the machinery by which the service is administered. This cannot be achieved on the basis of mere impressions. The collection of comparative statistics provides practically the only means by which the study can be made. To no organisation does this axiom apply more than to preventive medicine.

Sources.—The principal sources of information, apart from those already mentioned, are the annual reports of local Medical Officers of Health (which may be obtained from most large libraries or direct from the authorities concerned) and of the Chief Medical Officer of the Ministry of Health (H.M.S.O.).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Hospital and Specialist Services

The object of the hospital service is to remedy such sickness as may be more efficaciously treated by the hospital service than by other means. This implies first, identification of the patient specifically needing hospital treatment; second, designing clinical facilities for diagnosis and treatment of the disease pattern peculiar to the area, together with ancillary services of buildings, food, equipment, communications and secretarial assistance; third, welding these services together into an efficient organization; finally bringing the patient and organization together with minimal disturbance to either.

Beds

The first problem is to assess the demand for hospital beds. This depends upon the population served by the hospital group (this term is used loosely in the present context to identify any administrative unit), the incidence of illness severe enough to require hospital treatment, and the duration of hospital stay. For example, if the average duration of hospital stay is twenty days, then one bed will be used eighteen times in a year and will support an annual admission rate of eighteen. If 9,000 people require treatment every year then, ignoring seasonal fluctuation, 500 beds will exactly meet the demand. If we have not got the 500 beds then two things may happen; either a waiting list develops or the criteria for referral to hospital treatment change—for example the clinicians, aware of the limitation of resources, decide that only, say, 7,000 of the 9,000 really must have hospital treatment. Both these things may happen and unless arithmetic, of the kind suggested, is done, we do not know to what extent they happen, nor what effort is needed to repair the situation.

Suppose we wanted to do the arithmetic. How do we ascertain that 9,000 people need beds every year. Even if we know the proportionate incidence of illness (so many per 1,000 per year) we still have to ascertain the basic population to which to apply the proportion, i.e., what we call the number at risk, the number of people who, if they were to need hospital treatment would come into the group. We sometimes refer to the catchment area of the hospital group, but unfortunately it is not possible to fix any area such that the whole population and no other population is served by the hospital group; even a hospital region is not a watertight compartment in this respect. It is, however, possible to fix an approximate area surrounding the hospital group from which the bulk of the patients are drawn—that for example, the group serves mainly the administrative areas *X* and *Y*, the populations of which add up to 200,000. Norris (1952) has suggested another method based on census of patients in hospital on a particular day (or discharged over a period). The method assumes that, if of all residents in area *A* in the aggregate hospitals (taking every hospital in the field surveyed) 10 per cent. are in hospital *X* (or in cases of discharges were discharged from *X*), then 10 per cent. of area *A* will always choose *X* and hospital *X* may be regarded as serving one-tenth of *A*. If 20 per cent. of all hospitalized residents of *B* are in *X*, then *X* also serves one-fifth of *B*; and so on. The total population served by *X* is one-tenth *A* + one-fifth *B*, etc. The success of the method depends upon fixing the survey field so as to cover every hospital in which a significant number of residents from *A*, etc., may appear. The rate of occurrence of illness requiring hospital treatment is not known, since the only reporting system available is that resulting from the referral to waiting list and the records of emergency admissions and the criteria for hospital treatment have been constantly changing. However, either by reference to such records (and we underline their importance) or by local survey we might discover that 4·5 per cent. of the population require hospital treatment every year (a purely hypothetical figure) which would yield 9,000 admissions a year and require about 500 beds.

In all this the separation of teaching hospital numbers has to be taken into account. Equally the calculations should be made with reference not only to sex and age differentials, but also separate consideration should be given to important disease categories. Clearly current clinical policy in relation to tuberculosis or in relation to tonsillectomy is an important factor. It follows that adequate analysis of hospital discharges and of waiting list movements must be made to isolate these factors.

Clinical Policy

As an outcome of this examination of resources, an approach might be made to the elucidation of an outstanding problem of considerable importance and difficulty. Given a limited number

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of beds, which is below the potential demand, how are these beds to be used? The manner in which beds are used at present is hardly the result of any conscious policy. For different diseases there is a different waiting period, a different chance of admission to hospital based not on any rational policy, but upon the accident of circumstances, upon the interplay of outside pressure and the internal distribution of specialists, nurses and beds.

What should the rational policy be? Should it be directed to the maximum palliation of existing discomfort, e.g., concentration on disabling conditions; to the maximum suspension of mortality, e.g., concentration on fatal conditions; to the maximum prevention of ultimate disease, e.g., earlier operations in malignancy, or segregation of infectious cases. It is not for a statistician to say or for any administrator; but the clinicians and administrators as a team have to produce a policy.

Morbidity Surveys

In recent years, specialities have multiplied. From time to time the needs of research or the results of research reinforced by the need to direct the teaching of medicine to entities or procedures which have greater significance in medical education than may be justified by their numerical importance in post-graduate experience, lead to the institution of new departments in hospital treatment. The words "may be" are important. Sometimes the disease entity involved is numerically important, sometimes it is not. It may be economically the best way of dealing with the disease. The speciality is always important to the individual sufferer. The important point is that there is no overall examination of priorities or economies. The results could be that it is easier to get into hospital with disease *X* which is a modern curiosity, though far from an emergency, than if suffering from inoperable cancer. A general review of the treatment facilities for different diseases, both as they exist and as they might be on some rational assessment of human needs, is overdue.

This rational assessment must be based partly on philosophy, partly upon facts. The facts we require include the relative efficiency of different clinical facilities, the relative cost (not personal but social) of alternative methods of treatment (to both of these aspects we will return later) and the existing incidence of the conditions to be treated. The next objective is therefore the integration of morbidity statistics to produce a measure of total sickness. An important contribution to this end has been made by hospital discharge studies such as were carried out by municipal hospital authorities (Spear and Gould, 1937) between 1930 and 1940, and by the Nuffield Provincial Hospital Trust (1948, 1950), and such as has now been extended to national dimensions by the General Register Office (Mackay, 1951). This hospital discharge study involves the analysis, feasible in an era of punched cards, of summaries of in-patient treatments (discharge slips recording age, sex, diagnosis, source of admission, operative treatment, length of stay, etc.) over wide administrative areas. When added to statistics derived from local health authorities, for example of infectious disease, or of the chronic invalidity recorded by the district nursing associations (Macgregor and Benjamin, 1950) or by the domestic help service (Chalke & Benjamin, 1953) and to surveys of the case loads of general practitioners (Pemberton, 1949; Logan, 1952) it may be possible eventually to get a complete picture of the total therapeutic problem as well as the economic aspects of ill-health.

Time Trends

In this connection, time trends are important. These morbidity surveys need to be repeated in order that we discover whether diseases are increasing or decreasing in prevalence or severity and whether age or sex differentials are changing. It is wasteful to make long-term plans for the treatment of disease the disappearance of which is already assured. Before the war of 1939–45 there were 7,000 cases of diphtheria a year in the County of London; in 1952 there were under twenty cases. This dramatic decline was an anticipated result of immunization. Contrast this with the apparently rising incidence of cancer of the lung or the apparent increase in the incidence of coronary heart disease; about these changes we know little and much vigilance and study are called for. The possibility of taking such a wide view of any one disease may be defeated by the absence of sufficient official information (Benjamin and Nash, 1952). Commonly these secular trends have a connection with the changing structure of the population, e.g., the larger number of cancer

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

patients as the population grows older. Commonly the trends have specific local characteristics which repay statistical study on the domestic hospital group level.

Evaluation of Clinical Services

We return now to the consideration of a problem mentioned earlier; the examination of the relative efficiency and cost of different clinical facilities. Is it possible, is it cheaper to give as effective geriatric treatment to the aged sick in their own homes rather than in hospital? Most people answer this question in the affirmative, subject to reservations about special circumstances, but before this argument influenced public policy statistical demonstration of its foundation was necessary. Even as recently as 1948, it was necessary for Cosin to show that the aged and infirm need not be bedfast for long periods and that those cared for in long-stay annexes have only short terminal illnesses during which they need full nursing and medical care. Should we go on recruiting hospital midwives and opening up maternity beds for all those expectant mothers who prefer to be confined in hospital? Sometimes the preference is medically indicated, sometimes it is on the grounds of increased confidence conveyed by the proximity of specialist resources, but sometimes it is on personal financial grounds—a hospital confinement may be more costly to the State, but cheaper to the individual. Obstetric facilities are equally effective, provided that complications which need specialist services get them. Here, then, is a medico-social problem, the force of which is underlined by the statistics, without its solution being indicated.

Sometimes considerations of cost are wholly outweighed by the contrast in efficacy. If a treatment produces a proportion of cures in a disease which was formerly invariably fatal then monetary considerations are relevant only to the extent that limited national resources may impose restrictions.

More often than not marginal cases arise where the assessment of the relative effectiveness of therapeutic or diagnostic services is a real statistical problem. It is necessary to decide, for example, whether in tuberculosis, lung surgery is to compete with artificial pneumothorax or whether gastrectomy is to prevail over non-surgical treatment of peptic ulcer. The decision depends upon the carrying out of careful long-term follow-up of similar cases given different treatment and upon the tests of their relapse rates for significant differences. Much follow-up work can be wasted (in this respect, though not of course in relation to the well-being of the individual patient) either because it is not possible or no attempt is made to "control" the investigation, that is, to provide comparisons with similar groups treated differently; or because no proper attempt is made to examine the records statistically. Nevertheless, follow-up studies, though they cost money, make an invaluable contribution to the efficiency of treatment. Examples of methods have been given by Foster-Carter *et al.* (1953) and Paterson and Russell (1951). A national system of cancer registration is evolving in England and Wales (Stocks, 1950) and in Scotland.

On the diagnostic side, it is vitally important that there should be statistical justification for the employment of expensive equipment and highly skilled staff in the place of less costly means of ascertainment. There is perhaps no basis for criticism in this country where most observers are impressed by the contributions made by pathology and radiology to differential diagnosis and to the shortening of the interval between first symptoms and final diagnosis. The problem may sometimes lie in the proper application of diagnostic services; for example, to what population is it most productive to apply mass radiography; to the general public, to persons symptomatically selected by general practitioners, to patients admitted to general hospitals (in America the yield here is three times that in the general population), to contacts of tuberculous patients, to factories with respiratory hazards—there are advocates for many different specialized sections. Consideration has to be given not only to the yield in terms of cases of tuberculosis diagnosed per 1,000 X-rayed, but also the infective potentiality of those diagnosed. Finding one unsuspected infectious case in a factory may save the health of many workers. (Beddard, 1950, Nash *et al* 1953).

Local Studies

There are statistical comparisons which can and ought to be made between individual hospitals, but which are often neglected. It might be very revealing to compare the average duration of treatment in different hospitals for the same disease with the same degree of severity in similar

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

age and sex groups and to examine the reasons for differences. They might be due to differences in staff-bed ratios which clearly ought also to be compared; or to differences in the availability of surgical resources—hospitals have been known to out-grow their operating theatres; or to the creation of bottlenecks because patients wait for other procedures; or to differences in the arrangements for convalescence. It might be possible in this way to identify sources of unbalance in internal planning.

Similarly, comparisons of waiting list turnover would be worth while. The average wait for treatment *X* may be longer in hospital *A* than in hospital *B* while for treatment *Y* the reverse holds. It may be unavoidable; it may draw attention to the necessity for revising the allocation of beds; it may be evidence of differential "cross-hauling", i.e., for treatment *X* patients may prefer to travel long distances to hospital *A* to inflate the waiting list while for treatment *Y* the movement is in a different direction.

"Cross-hauling" is a study in itself. From time to time hospitals should examine the places from which their patients are drawn, if not in relation to diagnosis at least in relation to a broad division between medical and surgical cases. There may be mal-distribution of facilities within the group; there may merely be misunderstandings among general practitioners or patients. Whatever the reason, the information has to be sought.

How much time is spent on the average in the out-patient department: (*a*) by the patient arriving too early for an appointment? (*b*) in registration? (*c*) in waiting for attention beyond the appointed time? (*d*) in movement between registry and clinic? (*e*) in making reappointments, etc.? There is scope for an occasional time and motion study of this kind such as was recently carried out by Welch and Bailey (1952). If carried out in hospitals with differing routine and internal geography a comparison of the results would help to indicate optimum conditions.

Service Statistics

In one sense the administrator of a hospital is like the general manager of a large utility, intimately concerned with output, i.e., with measures of activity over a given period. He needs to know the size of the waiting list at periodic intervals (and not only how many are waiting, but how long they have been waiting) the admission and discharge movement, the average duration of stay. He must watch changes in the nominal bed complement, the numbers of beds out of commission by virtue of lack of staff or other reasons and the bed occupancy. An increase in the average occupancy from 85 per cent. to 90 per cent. in our hypothetical hospital of 500 beds means twenty-five beds more in constant use and on our hypothetical turnover 450 more patients treated every year; it could mean the elimination of a waiting list.

In addition to in-patient statistics we need to have a measure of out-patient attendances and of new out-patients. Both in-patient and out-patient statistics need adequate classification by department and type of hospital. We require also measures of the work done in casualty, physiotherapy, X-ray and pathological departments. In the production of service statistics individual departments should be prepared to forgo refinements which satisfy personal conceptions of precision in the interests of at least some degree of comparability between organizations. Otherwise each organization must either conform to the highest intensity of statistical analysis or live in a vacuum. Too often comparisons are not attempted because of a mere belief that they are impossible.

To make up the picture of the activity of the organization other statistics are necessary. Staff ratios and staff wastage—in particular there are statistical problems in job-analysis and in recruiting staff so as to secure adequate career progress The consumption of supplies of all kinds including food has to be assessed. The challenge is to obtain an adequate sense not only of activity, but also of efficiency with the minimum of *ad hoc* statistical organization or paper work. The skilled administrator will so arrange the day-to-day routine by intelligent design of clerical work and routing of paper that the statistical measures emerge with the minimum of effort.

Sources

Statistics of the hospital service in rudimentary form are published annually by the Ministry of Health in the Annual Report and in a separate annual publication entitled *National Health*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Service—Hospital and Specialist Services—Statistics (H.M.S.O.). More detailed analyses are prepared by certain Regional Hospital Boards—notably the Birmingham and Liverpool Regions. Some of the individual hospital reports are commendably informative; mention might be made of the Clinical Record of Cardiff Royal Infirmary,and the Statistical Report of St. Bartholomew's Hospital—all cannot be referred to and omissions should not be taken as lack of appreciation. The statistical analyses of both mental and general hospitals carried out by the General Register Office are published in morbidity volumes of the *Annual Statistical Review*.

The General Medical Services—General Practitioners

This third branch of the Health Service, though less well studied statistically than the other two branches, is not the least important—almost all forms of diagnostic and treatment activity have their focus in the family doctor. It is he who is best equipped to practice social medicine—he sees each member of the household against the background of that household as, so often, he has watched it grow; he sees each individual against the changing background of school or workshop experience which is revealed to him by constant contact with the family. It is the family doctor who more nearly sees morbidity as a whole than other workers in the Health Service.

Each Executive Council maintains a record of patients on the list of each doctor and an analysis of sizes of list has been published (Ministry of Health, 1953), but there is no general statistical survey of the patients treated by general practitioners or of the changing character of the work of general practitioners. There are several reasons why one of the most important sources of morbidity statistics has been so long neglected. The general practitioner is usually very busy. He is compelled to fill in a number of forms in connection with health insurance, death registration or referral to clinics and he is not anxious to engage in any further paper work from which he can see no direct return in greater efficiency but which may in fact get between him and his patients. There have, however, been socio-medical workers (Pemberton, 1949) and individual practitioners (McGregor, 1950; Fry, 1952) who have found in general practice a profitable field of research.

A pilot enquiry designed to discover how far records maintained in general practice might be used on a wider basis to provide useful information of general applicability was instituted by the General Register Office and the Ministry of Health in 1951 (Logan, 1952). The enquiry was particularly planned to cover a variety of practices "with a view to seeing whether size or situation of practice were associated with any special difficulty in record keeping; to testing different methods of recording; and to finding out how much, if any, extra trouble would be involved". The results have now been published (Logan, 1953).

The Social Medicine Unit of the Medical Research Council (Backett & Shaw, 1953) have reported a survey of an urban general practice in which attempts were made to measure the needs of patients and the services actually rendered by general practitioners.

The General Dental Services

Statistics of the dental work carried out under the British Health Service are at present provided by figures supplied by the Dental Estimates Board of applications for treatment, average cost of courses of treatment, and fees paid, and by figures of manpower supplied by the Ministry of Health. In addition the Dental Estimates Board do prepare analyses of the incidence of treatment of different kinds. These figures are published in the *Annual Report* of the Ministry of Health. Routine dental inspections are an integral part of school health services and the results are analysed and trends observed in the Annual Reports of School Medical Officers and in the Annual Report of the Medical Officer of the Ministry of Education. Some classical dental surveys in different parts of the country have been carried out by Lady Mellanby (e.g., Mellanby and Mellanby, 1952) who has encouraged the use of an index of dental conditions, d.m.f. (average number decayed, missing or filled) for group assessment; and special surveys have also been carried out in connection with the experimental addition of fluorine to water for protection against caries (Weaver, 1944). Thus there has been some examination of the need for treatment but no statistical test of the efficiency of treatment.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Ophthalmic Services

Reference should be made to the great industry of sight-testing and the supply of glasses which is largely in the hands of private enterprise but which through the operation of the National Health Service is subject to measurement on a national scale. Glasses are produced in the United Kingdom at the rate of 8,000,000 pairs a year, which is about sufficient to meet demand (Ministry of Health, 1952).

Information as to the incidence of optical defects is obtained mainly from the examination of schoolchildren (Ministry of Education, 1952) or recruits to or members of the Services (Ministry of Labour and National Service, 1952).

It is convenient to mention here that there is a national system of blind registration. At March 31st, 1951, there were 83,464 registered blind persons and new registrations number some 11,000 annually. The certificates of blindness have been used to provide analyses of causes of blindness and time trends in these causes (Sorsby, 1950, 1953).

The Clinical Trial

The clinical trial is not merely the recording of the progress, eventful or otherwise, of a group of patients undergoing a particular form of treatment, though the literature is still too full of such reports which attempt to pass muster as experiments. The progress of every individual patient is important and interesting; but it is not in itself a therapeutic trial. The object of an experiment is to test a hypothesis and the object of testing the hypothesis is to make a decision about future action (whether this be in treatment or prophylaxis). The clinician has to make that decision not the statistician. The statistician may compare the results of two treatments, upon agreed criteria, and he may calculate that one gives better results than another by a margin which is more than can be accounted for by chance; but the significance level he quotes is only a conventional numerical measure of confidence—confidence which he has the responsibility for imparting to or withholding from the clinician, who embraces the information in the mental attitude to the choice he alone must make. The trial is essentially comparative and therefore essentially statistical. Two groups of patients are compared dissimilar only in the presence or absence of the particular treatment factor it is proposed to subject to test. With human material the perfect factorial design is not easy to contrive. The particular difficulty of the medical as distinct from the agricultural or industrial trial is that it is so much more difficult for the statistician (whether he be in fact medical or lay) to understand the true character of the relationship which he is investigating—difficulties of definition and terminology of observation and of separation of bodily functions or of symptoms obtrude to a much greater extent than in other sciences. Complete collaboration between statistician and clinician to this end is vital (Bradford Hill, 1952). Since the clinician has to decide whether a particular significance level is to justify a change in therapeutic régime he is to apply in future it is inevitable and entirely laudable that statisticians have critically examined the logical foundations of their tests (Hogben & Wrighton, 1952). We go beyond the narrower arithmetical domain of common everyday statistical experience.

From a statistical point of view the trials carried out in recent years by the Medical Research Council (which has its own highly qualified statistical unit) may be regarded as classical. Of these perhaps the best known were the trials of chemotherapy in young adults to test the efficacy of streptomycin and combinations of streptomycin and para-amino-salycilic acid. An essential feature was that the patient admitted to the trials had to conform strictly to a particular definition (acute progressive bilateral pulmonary tuberculosis, believed to be of recent origin, bacteriologically proved, unsuitable for collapse therapy, age group 15–30). After acceptance by a panel the cases were randomly allocated to one or another treatment group; in each trial the different treatment groups were treated and observed concurrently; the clinical and radiological examinations and record keeping were made according to a plan previously agreed by all concerned; and finally the results of each trial were analysed by the same team of experts. (Daniels and Hill, 1952.) All clinical and laboratory procedures were carefully standardized. Comparisons were therefore valid from the outset and the results were accepted with confidence as the basis of future treatment.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Diagnosis

As we have inferred in the introduction diagnosis is a comparative science. Abnormality is only determined by studying normality. Twenty years ago it was said that "we have always been more ready to study disease and to treat it than to make the basic anthropological and statistical studies that would enable us to say where normal ends and disease begins" (Vanzant, Alvarez *et al.*, 1932). This is fortunately less true today but there is still considerable scope for such studies, whether it be of gastric acidity, blood pressure, physical measurements, or of any of the manifold elements, standards of which might be needed in the assessment of morbid conditions.

Differential diagnosis is, as Ryle (1936) has stressed, an exercise in precise observation; but that observation is likely to be so much more profitable if there is brought to it a prior knowledge of the frequencies of symptoms associated with recognized disease entities. White and Geschickter (1947) have developed this statistical approach into the construction of a routine diagnostic survey. This routine utilizes as its basis, procedures which have been derived from a statistical survey of the association of abnormalities, in early or presymptomatic stages as well as later stages, with the various diseases to be recognized.

The Cornell Medical Index Health Questionnaire (Brodman, K., *et al.*, 1949) is based upon similar notions (as well as upon the belief that the search for symptoms is likely to be more complete if signposted). The patient himself completes the questionnaire. The C.M.I. has been used for four years in the New York Hospital. Physicians, by its use, can not only forecast practically all the diagnostic categories in which disease will later be discovered but they can usually name the actual diseases which are present. More significant still the C.M.I. has often disclosed evidence of disease which was later overlooked both in outpatient and inpatient investigation.

Other diagnostic procedures, the accessories of the five senses, such as X-rays, blood tests, cardiograms, etc., are costly in time, equipment, medical manpower and are not infallible. It is therefore important not only that the inherent observer error in each procedure should be fearlessly assessed and subsequently incorporated into the use of the procedure—this has recently been illustrated for chest X-rays (Cochrane and Garland, 1952) and also for clinical note-taking (Cochrane, Chapman and Oldham, 1951)—but also important that comparison should be made of the relative efficiency of different procedures which are directed to the same end. This last field of research has been relatively untouched.

Genetics

The mathematician has a special contribution to make in the field of genetics and through it, as Bailey (1951) has pointed out, to medicine as a whole. Bacterial mutation underlying the emergency of drug resistance is essentially in this statistical field (Lurie and Delbruck, 1953); the assessment of the risks of rhesus negative women in pregnancy is also a genetic study; these are topical examples quoted by Bailey (*ibid.*), who stresses also the potential application of the study of hereditary factors in the aetiology of disease. As a recent example of the latter we may quote the study of Kallman and Reisner in tuberculosis (1946). Burnet (1953) speaks of the genetic deterioration of our species which is in process and places its study and ultimate prevention as *the* great task of future medical research. "The evolution of the body and of the defects of the body fall within the realm of genetics. Mendel's laws hold for man; there are biochemical mutants in man as well as in the moulds and bacteria that the microbial geneticist studies. Equally we can be certain that the line of mammalian evolution that led up to man was directed by the same process of gene mutation, recombination of gene patterns, and natural selection that can be seen at work in organisms susceptible to direct genetic investigation. Mutation by its very nature must normally be harmful—the mutation or combination of mutations leading to improvement of the type must inevitably be rare. Progressive evolution, in Fisher's words, is a miracle wrought by selective survival in the teeth of a storm of deleterious mutations". The study and eventual control of the "storm" is a statistical challenge.

APPENDIX

The General Register Office.—Medico-statistical information is furnished by the General Register Office in a number of different ways.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The principal vital statistics for each calendar year for individual districts are supplied regularly to local medical officers of health as soon as possible after the end of the year, i.e., in April or May under normal conditions. The figures include estimates of population, numbers of births by sex and legitimacy, numbers of deaths by sex classified to the 36 groups of the abridged list of causes used in the Registrar General's Statistical Review and to certain special individual causes, numbers of deaths of children under one year of age by sex and legitimacy and a summary of the principal rates in England and Wales as a whole.

In addition, the medical officers of health for counties, county boroughs and the metropolitan boroughs of London are supplied with the age distribution of the deaths classified to the 36 headings of the abridged list. By special arrangements certain other details are supplied to individual medical officers of health.

Without knowledge of the population at risk the detailed analysis of the recorded birth, death and marriage statistics would be of limited value. Estimates of the population of various kinds are also required by Government Departments and other bodies for administrative purposes. Such estimates have been made in the General Register Office for many years and for the country as a whole estimates by sex have been carried back to 1801. From 1838 estimates by sex and age groups are available for England and Wales and a further breakdown by sex, age and marital condition has been made at ten-yearly intervals from 1851 and at each year from 1911 for females and from 1931 for males.

The above-mentioned estimates relate to England and Wales as a whole. Estimates by sex and age are made for regions and density aggregates (that is, aggregates of certain kinds of urban and rural areas). For individual local areas the estimates, in the main, have been restricted to the total population without any distinction of sex or age, but during recent years estimates of the number of children under 15 years of age in each local government area have been made.

The Registrar General's Weekly Return

The Return, which is published on the Saturday following the week to which it relates, contains:

(i) A record of the numbers of births, stillbirths, deaths, infant deaths and deaths from some of the principal epidemic diseases registered in the preceding week in the county boroughs and other "Great Towns" of more than 50,000 population (as at the 1951 Census), making 160 in all.

(ii) A serial record of these figures and of notifications of certain infectious diseases for London and the aggregate of the 160 Towns for the current and preceding weeks, with cumulative totals up to date and corresponding figures for recent years.

(iii) A record of the deaths by age and from the principal causes in London.

(iv) A record of the numbers of cases of infectious disease notified in each local government area.

(v) A record of the numbers of new claims to sickness benefit made under the National Insurance Act in the current week and three preceding weeks, together with weekly averages for the last twelve months, for England and Wales and the Standard Regions. These statistics are supplied by the Ministry of National Insurance.

(vi) Values of air temperature and rainfall in certain large towns and meteorological observations taken at Kew Observatory, Richmond, supplied by the Meteorological Office.

The Registrar General's Quarterly Return

This publication, which is generally published before the end of the quarter following that to which it relates, contains:

(i) Estimates of the national population, civilian, home and total by sex and certain age groups.

(ii) A serial record of the principal quarterly and annual figures of births, stillbirths, marriages, deaths, infant deaths and deaths under 4 weeks.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(iii) A serial record covering the preceding five quarters of birth and death rates, and rates of deaths from certain epidemic diseases.

(iv) A table showing the home population, births, stillbirths, marriages, deaths, and deaths of children under one year in England and Wales and each of the counties.

(v) A summary for the calendar quarter for London and the 160 Great Towns compiled from the weekly cards, together with the latest estimate of their home populations.

(vi) A record covering the same topics submitted quarterly by the Registrars in the Smaller Towns which had a population of between 25,000 and 50,000 at the 1951 Census.

(vii) Records of the numbers of notified cases of infectious disease compiled from the special quarterly returns from Medical Officers of Health.

(viii) A record of the number of births and deaths in certain cities abroad, and infant mortality by quarters over the last few years in several countries other than England and Wales, compiled from special returns sent by them.

(ix) A table showing the numbers of deaths from the principal causes, distinguishing sex, registered in England and Wales in the calendar quarters of the current and two preceding years. The latest quarter available is generally that preceding the one to which the return relates.

(x) A table showing the numbers of insured persons absent from work owing to certified sickness or industrial injury (or prescribed disease) on specific days in three consecutive months in England and Wales and in the Standard Regions. These figures are supplied by the Ministry of National Insurance.

(xi) Values of air temperature, rainfall and sunshine in districts of England and Wales in each month of the calendar quarter, together with a commentary, supplied by the Meteorological Office.

Certain non-quarterly information is included in the issues for certain quarters of the year, e.g., the June and December Returns contain lists of any changes of boundaries of administrative areas which may have been made during the six months ending June 30th and December 31st; the March Return contains a detailed analysis of deaths assigned to London, by cause and age, and information on population, births and deaths in England and Wales and within the Great and Smaller Towns during the preceding year; the December Return also contains some annual vital statistics and a textual summary relating to the experience of the country as a whole in the year then ended.

The Registrar General's Statistical Review (Annual)

In normal years this Review appears in three volumes, two containing statistical tables (Part I, Medical, and Part II, Civil) and the third a "Text" or commentary with additional tables. This arrangement has been modified for the years of the 1939–1945 war, when the Review could not be published currently. Separate volumes of Medical and Civil Tables have been published for each year, but the Text volumes for 1938 and 1939 were combined, and a single commentary on the years 1940 to 1945 has been written in two volumes, one Medical, the other Civil. The medical texts for 1946 and 1947, and for 1948 and 1949 are single volumes and commencing with 1949 there are special morbidity parts. For civil text purposes the years 1946–50 have been dealt with in one volume.

The Review contains all the detailed vital statistics compiled in the processes described above, and also contains those derived from the morbidity data which have recently become available. Part I deals, therefore, mainly with mortality statistics and statistics of the notifiable infectious diseases. Part II contains statistics of births, marriages and population, and since 1938 of fertility also. The Text contains a critical commentary on the principal features of the figures published in the volumes of tables together with special analyses and tabulations. From time to time in the medical volume a few diseases are selected for fairly exhaustive examination of trends and over the course of the years the Text provides a complete analysis of the major trends in vital statistics such as is not to be found in any other source. Similarly, the civil volume of the Text provides detailed examination of modern measures of population replacement.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Registrar General's Decennial Supplements

These are normally published in several parts. They provide detailed analyses of mortality and fertility by occupations, together with life tables and, occasionally, analysis of multiple or secondary causes of death. Until 1931, analyses for local areas of mortality from different diseases during the decennial period then ended were also included.

Studies on Medical and Population Subjects

This comprises a series of occasional publications designed to provide in convenient form a more extensive treatment of important subjects than is practicable within the limits of the annual Statistical Review. Those so far published are:

(1) "Regional and Local Differences in Cancer Death Rates" by Percy Stocks, M.D., D.P.H.

(2) "Sickness in the Population of England and Wales in 1944–1947" by Percy Stocks, C.M.G., M.D., F.R.C.P.

(3) "Cancer Registration in England and Wales" by Percy Stocks, C.M.G., M.D., F.R.C.P.

(4) "Hospital Morbidity Statistics" by Donald MacKay, M.A., M.B.

(5) "Internal Migration" by Mary P. Newton, M.A., and J. R. Jeffery.

(6) "External Migration" by N. Carrier, M.A., and J. R. Jeffery.

(7) "General Practitioners' Records" by W. P. D. Logan, M.D., Ph.D.

The General Register Office of England and Wales (and its counterpart in Scotland) is the major source of mortality and morbidity statistics, and students of medical statistics should regard as essential a working familiarity with its publications.

The Registrar General's Office, Scotland

The office publishes:

(1) A weekly return containing the births and deaths and marriages and related rates in principal towns; a classification of deaths showing those due to epidemic disease, tuberculosis, respiratory disease, violence, those under 1 year and those over 65 years of age; certain meteorological details.

(2) A quarterly return giving similar information as in the weekly return for Scotland and local areas with figures for the quarters of previous years; deaths in Scotland during the quarter by cause and age; deaths by cause in the counties and large burghs; meteorology.

(3) An Annual Report with detailed statistical tables and commentary both medical and civil.

References

Medicine and Statistics

FINNEY, D. J. (1947), *Probit Analysis*. C.U.P.
PAGE, SIR MAX (1947), *Proc. R. Soc. Med.*, **91**, 113.
RYLE, J. A. (1947), *Lancet*, i, 1.

Administration

WINSLOW, C. E. A. (1951), *The Cost of Sickness and the Price of Health*. Geneva: W.H.O.

Vital Statistics and Local Health Authority Statistics

BAILEY, N. J. T. (1950), *Biometrika*, **37**, 194.
—— (1951), *J. Hyg.*, **49**, 81.
BARTLETT, M. S. (1949), *J. R. Statist. Soc.* B, **11**, 211.
BENJAMIN, B. (1953), *Brit. J. Tubercle*, **47**, 4.
—— & GORE, A. T. (1952), *Brit. J. Soc. Med.*, **6**, 197.
BREEN, G. E., BENJAMIN, B., & BECK, A. (1950), *Lancet*, i, 198.
CHALKE, H. D., & BENJAMIN, B. (1953), *Lancet*, i, 588.
CHARLES, E. (1951), *Brit. J. Soc. Med.*, **5**, 41.
COX, P. R. (1950), *Demography*. C.U.P.
DALEY, SIR ALLEN (1952), *Rep. Med. Offr. Hlth. L.C.C.*, 1951.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

DAVID, S. T. (1952), *Tubercle, Lond.*, **33**, 78.
GEORGE, J. T. A., LOWE, C. R., & MCKEOWN, T. (1953), *Lancet*, i, 88.
GORE, A. T., & PALMER, W. T. (1949), *Lancet*, ii, 385.
GREENWOOD, M. (1946), *J. R. Statist. Soc.*, **109**, 85.
—— (1948), *Medical Statistics from Graunt to Farr.* C.U.P.
GREENWOOD, M., HILL, A. BRADFORD, TOPLEY, W. W. C., WILSON, J. (1936), *Med. Res. Com. Spec. Rep.*, No. 209.
GRUNDY, F., & TITMUSS, R. M. (1945), Report on Luton. Luton: Gibbs, Bamforth.
—— —— (1946), *Lancet*, ii, 687.
HILL, A. BRADFORD, & MARTIN, W. J. (1949), *Brit. Med. J.*, ii, 357.
KERMACK, W. O., & MCKENDRICK, R. G. (1927), *Proc. R.S.A.*, **115**, 700; **138**, 55; **141**, 94.
LLOYD, F. J., & SPRATLING, F. H. (1951), *J. Inst. Actu.*, **77**, 196.
NEWSHOLME, A. (1889), *Vital Statistics.* London: Allen and Unwin.
SCOTT J. A. (1953), *Brit. J. Soc. Prev. Med.*, **7**.
SOPER, H. E. (1929), *J. R. Statist. Soc.*, **92**, 34.
STEWART, A. M., & RUSSELL, W. T. (1952), *Med. Offr.*, **88**, 5.
STOCKS, P. (1949), *Stud. Med. Popul. Subj.*, 2.
TANNER, W. J. (1952), *Arch. Dis. Childh.*, **27**, 10.
WILSON, E. B., & WORCESTER, J. (1945), *Proc. Nat. Acad. Sci., Wash.*, **31**, 203.
WOFINDEN, R. C., & EMBLEM, R. G. (1953), *Med. Offr.*, **89**, 5.

Hospital Service

BEDDARD, F. D. (1950), *Tubercle*, **31**, 286.
BENJAMIN, B., & NASH, F. A. (1952), *Tubercle, Lond.*, **33**, 73.
CHALKE, H. D., & BENJAMIN, B. (1953), *Lancet*, i, 588.
COSIN, I. (1948), *Proc. R. Soc. Med.*, **41**, 333.
FOSTER CARTER, A. F., MYERS, M., *et al.* (1953), *Brompton Hospital Reports.*
MACGREGOR, M., & BENJAMIN, B. (1950), *Med. Offr.*, **84**, 227.
MACKAY, D. (1951), *Stud. Med. Popul. Subj.*, 4.
NASH, F. A., BENJAMIN, B., LEE, T. J. (1953), *Brit Med. J.*, i, 304.
NORRIS, V. (1952), *Brit. Med. J.*, i, 129.
Nuffield Provincial Hospital Trust (1948), *Hospital and Community. I. Stirlingshire.*
—— (1950), *Hospital and Community. II. Ayrshire.*
PATERSON, R., & RUSSELL, M. (1951), *Christie Hospital and Holt Radium Institute Third Statistical Report*, Livingstone.
PEMBERTON, J. (1949), *Brit. Med. J.*, i, 306.
SPEAR, B. E., & GOULD, C. A. (1937), *Proc. R. Soc. Med.*, **30**, 633.
STOCKS, P. (1950), *Stud. Pop. Med. Subj.*, 3.
WELCH, J. D., & BAILEY, N. T. J. (1952), *Lancet*, i, 1105.

General Practice

BACKETT, E. M., & SHAW, L. A. E. (1953), *Proc. R. Soc. Med.*, **46** 707.
FRY, J. (1952), *Brit. Med. J.*, ii, 249.
MACGREGOR, R. M. (1950), *Edinb. Med. J.*, **7**, 433.
LOGAN, W. D. P. (1952), *Bull. Minist. Hlth.*, Sept., 224; (1953), *Stud. Med. Pop. Subj.*, 7.
PEMBERTON, J. (1949), *Brit. Med. J.*, i, 306.
Ministry of Health (1953), *Ann Rep.*, 1952. H.M.S.O.

Dental Service

MELLANBY, M., & MELLANBY, H. (1952), *Brit. Med. J.*, i, 7.
WEAVER, R. (1944), *Brit. Dent. J.*, **76**, 29.
—— (1950), *Brit. Dent. J.*, **88**, 231.

Ophthalmic Service

Ministry of Health (1952), *Ann. Rep.*, 1951, H.M.S.O.
Ministry of Education (1952), *Rep. Chief Med. Offr.*, 1948, 1949. H.M.S.O.
Ministry of Labour and National Service (1952), *Ann. Rep.*, 1951. H.M.S.O.
SORSBY, A. (1950), *Med. Res. Coun. Memor.*, No. 24. H.M.S.O.; (1953) Ministry of Health. H.M.S.O.

Clinical Trials

DANIELS, M., & HILL, A. BRADFORD (1952), *Brit. Med. J.*, i, 1162.
HILL, A. BRADFORD (1951), *Brit. Med. Bull.*, **7**, 278.
HOGBEN, L., & WRIGHTON, R. (1952), *Brit. J. Soc. Med.*, **6**, 89.
—— (1952*b*), *Brit. J. Soc. Med.*, **6**, 205.

Diagnosis

BRADMAN, K., ERDMANN, A. J., jun., *et al.* (1949), *J. Amer. Med. Ass.*, **140**, 530.
COCHRANE, A. L., & GARLAND, L. H. (1952) *Lancet*, ii, 505.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

COCHRANE, A. L., CHAPMAN, P. J., & OLDHAM, P. O. (1951), *Lancet*, i, 1007.
RYLE, J. A. (1936), *Natural History of Disease*. Oxford Univ. Press.
WHITE, B. V., & GESCHICKTER, C. F. (1947), *Diagnosis in Daily Practice*. Philadelphia: Lippincott.
VANZANT, F. R., ALVAREZ, W. C., *et al.* (1932), *Arch. Intern. Med.*, **49**, 345.

Genetics

BAILEY, N. T. J. (1951), *Brit. Med. J.*, i, 8.
BURNETT, SIR MACFARLANE (1953), *Lancet*, i, 103.
KALLMAN, F. J., & REISNER, D. (1943), *Amer. Rev. Tuberc.*, **47**, 549.
LURIA, E. S., & DELBRUCK, M. (1943), *Genetics*, **28**, 491.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

PAGE

1.—*Braithwaite* (*R. B.*). Scientific Explanation: A Study of the Function of Theory, Probability and Law in Science 233
2.—*Wold* (*Herman*) *& Juréen* (*Lars*). Demand Analysis: A Study in Econometrics 235
3.—*Charnes* (*A.*), *Cooper* (*W. W.*) *&*}*Henderson* (*A.*). An Introduction to Linear Programming 236
4.—*Hansen* (*M.*), *Hurwitz* (*W.*) *& Madow* (*W.*). Sample Survey Methods and Theory 236
5.—*Kendall* (*M. G.*). Exercises in Theoretical Statistics 237
6.—*Romig* (*Harry G.*). 50–100 Binomial Tables 237
7.—National Bureau of Standards. Applied Mathematics Series. Tables of 10^x (Antilogarithms to the Base 10); Table of Natural Logarithms for Arguments between Zero and Five to Sixteen Decimal Places 238
8.—*Carrier* (*N. H.*) *& Jeffery* (*J. R.*). External Migration: A Study of the Available Statistics, 1815–1950 238
9.—*Utting* (*J. E. G.*). Social Accounts of Local Authorities: An Experiment in Sampling Methods 239
10.—*Schlote* (*Werner*).—British Overseas Trade from 1700 to the 1930's . . . 240
11.—*Matthews* (*R. C. O.*). A Study in Trade Cycle History, 1833–42 . . . 242
12.—*Martin* (*Anne*) *& Lewis* (*J. Parry*). Welsh Economic Statistics 243
13.—British Transport Commission. Bristol on the Move 243

1.—*Scientific Explanation: A Study of the Function of Theory, Probability and Law in Science* By R. B. Braithwaite. Cambridge: University Press, 1953. xii + 376 pp. $8\frac{1}{2}''$. 40*s*.

Three different sorts of problem are considered in this book. About half the book is devoted to a discussion of the meaning and function of universal scientific generalizations or laws (of the form, "Everything which is *A* is also *B*"). The author is concerned with "the straight logical problems of the internal structure of scientific systems and of the roles played in such systems by the formal truths of logic and mathematics". Secondly, there is a discussion (in chaps. 5 and 6) of the meaning of statistical hypotheses, such as typified by "There is a probability of 0·51 that a human birth will be the birth of a male". Thirdly, there is a discussion of the choice between alternative statistical hypotheses (chap. 7) and of "the problems of inductive logic or epistemology concerned with the grounds for the reasonableness or otherwise of accepting well-established scientific systems" (chap. 8 and a part of chap. 12). Very briefly, we may say that the book deals with (i) universal hypotheses, (ii) statistical hypotheses and (iii) induction.

The topics considered under the first of these heads include the following. The logical structure of a scientific theory, consisting of a hierarchy of hypotheses organized in a deductive system, is described; and a careful distinction is drawn between a deductive calculus, which may be thought of as a one-person game with symbols played according to specified rules, and the interpretation of such a calculus as a scientific theory. Logically, a scientific theory is organized by deduction, starting from the highest-level hypotheses as premisses, but the meaning of the theory lies in the relation of the lowest-level hypotheses with experience. The meaning of theoretical terms such as "electron", occurring in the higher-level hypotheses of a theory, is discussed; and the view that such terms are logical constructions out of the observations is refuted, by simple examples. There follows a discussion of the relation of a scientific theory to a model for that theory, in which all the terms occurring in the theory, including the theoretical terms, are interpreted as observables in a system having the same structure as the original theory. The advantages and dangers of thinking in terms of models are illustrated.

Professor Braithwaite takes an empirical view of the nature of a scientific generalization or law, namely that "Everything which is *A* is *B*" means simply that the property *B* is constantly conjoined with the property *A*, so that in fact everything which is *A* is also *B*. This is the minimum interpretation. Many philosophers have held a stronger view that a scientific law implies, not merely a constant conjunction of properties, but something analogous to logical necessity. Towards the end of the book Professor Braithwaite defends his empirical position by discussing a number of logical paradoxes and puzzles that have been held to present difficulties from this point of view. He shows that a satisfactory analysis can be given of the difference between a "law of nature" and a "mere generalization", of the idea of a "causal law", and of causal and teleological explanations of facts.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The whole of this discussion of the logical character of scientific theories seems to me beautifully clear, convincing and illuminating. The author is concerned to present a positive coherent account, rather than to criticize other people's views, but plentiful references to previous work are given, and his treatment can therefore serve as an introduction to the literature.

A statistician is likely, however, to be more particularly interested in the remaining portions of the book, dealing with statistical hypotheses and induction. Here, while the lucidity of style is maintained, the result seems to me less satisfying. The author considers only a few of the many questions that present themselves, so that an impression of scrappiness is given; and it seems to me that the treatment of the questions that are considered is not altogether adequate.

The discussion of the meaning of statistical hypotheses begins with an exposition of a modification of R. A. Fisher's model of sampling an infinite population. A sample of n readings such that each has probability p of exhibiting a certain property, p being a rational number l/m, is represented by a model in which an n-handed Briareus draws one ball simultaneously out of each of n bags each containing l black balls and $m-l$ white balls. Finite bags are considered instead of infinite bags, to avoid talking nonsense; and simultaneous drawings from n similar bags are preferred to a repeated drawing from one bag, with replacement, since the latter introduces an ordinal notion which the author wishes to avoid. Then an account of the empirical meaning of probability hypotheses is given in terms of a hierarchy of significance tests, to be applied to the observations from time to time as they accumulate. On any one occasion the test may lead to the rejection of the hypothesis, but such a rejection is only provisional and may be cancelled by a subsequent test. The tests actually given are of low sensitivity, partly because, to avoid all but the most elementary mathematics, the author has used the Bienaymé-Chebyshef inequality instead of exact distribution theory, and partly because he has arranged the tests in a wasteful hierarchic system. But they could easily be replaced by more efficient tests without affecting the main argument.

It seems to me that a criticism could well be made of this analysis of the meaning of probability statements, that ordinal considerations have been deliberately excluded, whereas I should say they are essential. The phenomena occurring with games of chance that the theory of probability was originally developed to describe have two properties, (i) local chaos, often summed up in the phrase "impossibility of a gambling system", and (ii) long-run stability of frequencies. Professor Braithwaite has discussed probability primarily in terms of the second of these properties. If one has to explain the meaning of probability statements occurring in a scientific theory, e.g., in the theory of genetics, I suggest one should begin by saying that an analogy is being drawn between the phenomena of the science and those of simple games of chance, and then go on to describe tests one might make for the adequacy of the analogy. Such tests would relate not only to stability of frequencies but also to local chaos.

Professor Braithwaite's discussion of induction begins with a very readable account of A. Wald's ideas of minimax decision functions; a simple example is explained in detail. There is a persuasive defence of the use of randomized strategies. (It would have been interesting if the author had added an equally persuasive attack on them, though he could hardly do this without abandoning his rigidly frequentist view of probability.) The main reason for discussing Wald's theory is to show that considerations of utility or purpose may be relevant in choosing between alternative hypotheses. The author then passes on to the old philosophical problem of the justification of induction. The traditional attempt to assimilate induction to deduction is rejected, and attention is turned to justifying, not individual inductive inferences but the whole policy of making inductive inferences according to recognized principles. "These inductive principles are those discussed in books on inductive logic and scientific methodology"; Professor Braithwaite does not go into details. His justification of the policy of induction is that it works, that is, that it frequently leads to the making of correct predictions ; and there is a long argument to show that there is no vicious circularity in this justification.

All this is excellent as far as it goes. An incompleteness in the treatment is revealed, however, by the occurrence of a flat contradiction (the only one I have noticed). On p. 359 the following remark occurs, reiterating what has been said several times earlier: "The discovery of a contrary instance will expel an established universal hypothesis from this rational corpus [of knowledge and reasonable belief]". On p. 360 we read: "It is simply not the case that every universal hypothesis is regarded as having to be rejected by the discovery of one contrary instance". To have avoided saying what is simply not the case would have required a more explicit discussion than Professor Braithwaite has in fact given us of the grounds for accepting and rejecting hypotheses—not only statistical but any hypotheses.

I am sure this is an important book, both for its positive doctrine and for the dead wood cleared away. If it does not dispose of every philosophical question that a statistician might ask, it will most certainly help to clarify thought and stimulate further investigation. F. J. ANSCOMBE.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2.—*Demand Analysis: A Study in Econometrics.* By Herman Wold in association with Lars Juréen. New York: Wiley (Stockholm: Almqvist & Wicksell), 1953. xvi + 358 pp. 9″. 56*s*.

The first impression made by this book is one of excitement. Here, at last, it seems, is a book which deals with an econometric question in all its aspects and uses recent developments in methods of analysis. On closer study, however, one is left with a growing feeling of disappointment. Professor Wold discusses a large number of topics connected with demand theory and the statistical analysis of demand. His treatment of the topics is always interesting and frequently revealing, but in many cases one feels that they have little direct connection with his main theme. This would not matter if it did not lead to compression, and sometimes obscurity, in the treatment of more important and relevant questions. One is also liable to get rather irritated at the frequency with which one is told that "we shall now state without proof . . . ."

The book is divided into five parts. In many ways the broad survey of Part I is the most interesting. Much of the discussion centres on the criticisms in recent years of the application of least-squares regression to economic data. Wold takes pains to rescue the method from its attackers. His main method of defence is to investigate the causal nature of the relations in a dynamic economic model. He builds a case for recursive systems as covering most of the models in dynamic economics. He also shows that any set of stationary time-series can be approximated by a linear recursive system with disturbances obeying the hypotheses required for least-squares regression. With the required hypotheses, least-squares regression is unbiased. The impression left with the casual reader will be that shown by the last sentence of Chapter 2: "In demand analysis, at least, it (regression analysis) can still be safely recommended." The qualifications can easily be overlooked. As Wold admits, the approximation by a linear recursive system does not give causal relationships, so that the theorem on the resolving power of linear recursive systems loses much of its significance in this context. Also the hypotheses on the disturbances when we do have linear recursive systems as our economic model are crucial to the unbiased nature of our regression. Their meaning and importance seems to be given far too little stress. Wold suggests that approaches such as structural systems which ignore causal interpretation are throwing away the baby with the bath-water. While one is grateful to him for his attempt to refill the bath, one sometimes suspects that it is now stocked with red herring and not with baby.

Part II deals with the economic theory of demand. It is largely a shortened version of Wold's articles in *Skandinavisk Aktuarietidskrift*, 1943–44. Some obscurity creeps in, for example, in his discussion of the scarcity region when relaxing his assumptions to deal with the possibilities of satiety and of nondivisible commodity units. He presents some useful relations between elasticities but proceeds to the discussion of various topics such as barter and price indexes which, as treated here, seem irrelevant. The real problems of the use of price indexes in demand analysis do not appear to be tackled.

Part III deals with stationary random processes. Here, more than anywhere else in the book, Wold appears to give a lot of results, mainly without proof, which are not subsequently needed. This part is not likely to satisfy those who want to discover something about random procesess as such and may well bewilder others.

Part IV deals with regression analysis and is based on simple theory of real Hilbert space. It goes on to consider special topics connected with applications to family budget data and to market statistics. The discussion, although at a much simpler theoretical level than much that has gone before, deals with important practical questions such as the difference between results using quantity or expenditure as regress, and the difference using budget data and time series, the scales for conversion to consumer units, and the problem of trend. Unfortunately there is once again obscurity. For example, the discussion of the effect of varying prices, due to quality variations or price discrimination, on quantity and expenditure elasticities derived from budget data involves the use of symbols which are not clearly defined and which do not appear to have the same meaning in the two relations given. The algebra on the differences between income elasticities of family budget data and of market statistics due to novel commodities is not clear and the result, which is several times referred to in Part V, is surely the wrong way round.

Part V, in which Mr. Juréen has collaborated, presents empirical findings of demand studies in Sweden. The analyses mainly relate to food and are used as the basis of long term forecasts of the Swedish demand for foodstuffs, which were required in connection with agricultural policy.

Wold presents a large number of valuable exercises on the subjects dealt with in Parts II, III and IV. His notes and bibliography provide a useful and extensive set of references.

The critical nature of this review must largely be blamed on the high hopes raised by the book. In spite of all its faults it remains a very notable addition to econometric literature which must be read by all who wish to keep abreast of the subject.

W. J. CORLETT.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3.—*An Introduction to Linear Programming*. By A. Charnes, W. W. Cooper & A. Henderson. New York: J. Wiley. (London: Chapman & Hall Ltd)., 1953. ix + 74, pp. 11″. 20$.

This little book is divided into two parts, of which the second, a set of lectures by Charnes, is the more important. Beginning with simple operations on vectors, most of the exposition is based on linear transformations. This makes the book intelligible to those familiar with elementary matrix algebra and might have made it possible for the author to dispense altogether with topological concepts such as convex polyhedral cones. The standard simplex technique for solving programming problems is discussed at length, together with a new version of Charnes' "Econometrica" paper on degeneracy. As long as the simplex method is the best available form of computation, lectures V and VI will be the most useful of the whole book. This whole part is well presented, though occasionally more detail would be welcome, detail which must have been part of Charnes's original lectures. Misprints are few and unimportant. Compared with other literature in this field there is no undue insistence on rigour, generality and first principles.

The first half of the book is somewhat disappointing. It covers the same ground as the second half, omitting most of the mathematics, and shows, by means of an example worked in full, how solutions are obtained. However, a discussion of the relevance of the linear programming technique for economic theory would have been appropriate: it would have been instructive for the economist to be shown that a programming solution is equivalent to general economic equilibrium. At the same time this particular form can, with a little ingenuity, be easily extended to cover in a realistic manner a large number of cases relevant in theory and practice. There is little indication of the various types of problems to which linear programming can be applied, though this is partly remedied by a good bibliography, and of the technique needed to translate from one mode of expression to the other. After all, at the elementary level, linear programming is very easy and this part ought to have shown how practical problems can be set up, leaving the computational side to the expert. It is along those lines, hardly ever touched by the authors, that economists and practical men can most easily be persuaded of its usefulness. As it is, this first part, called "Economic Introduction to Linear Programming," is unlikely to convince the reader that this new tool is really useful.

G. MORTON.

4.—*Sample Survey Methods and Theory*. By M. Hansen, W. Hurwitz and W. Madow. Vol. I. Methods and Applications. xxii + 638 pp. 9″. 64*s*. Vol. II. Theory. xiii + 322 pp. 9″. 56*s*. New York and London: Wiley, 1953.

All three authors are members of or have been connected with the United States Bureau of the Census, which over the course of the last fifteen years or so has made increasingly greater use of sampling methods. The aim has been to produce both a text-book and a reference book. Wisely the authors have produced two volumes, the first and larger volume dealing with a description of methods and their application while the second deals with the derivation of the formulae used in the first volume.

Volume I devotes the first hundred pages or so to an excellent non-technical introduction to the principles of sample design. It then progresses from simple random sampling in Chapter 4 to stratified single or multi-stage cluster sampling in Chapter 7 with a special section on multi-stage sampling with large primary sampling units in Chapter 9. Throughout the aim is to obtain the optimum distribution between stages and the optimum size of cluster.

Here the reader should be warned that most of the examples given relate to area sampling. Thus the cost functions used relate to that type of sampling where part of the cost arises at the penultimate stage of sampling in preparing a list. It should also be remembered that the use of 68 large fixed primary units in many of these samples (counties or combinations of counties in the main) was largely determined by the decision to have one full-time supervisor for each unit.

Double sampling, sampling for time series, and systematic sampling are discussed in Chapter II. Finally the last hundred pages of Volume I are devoted to five case studies.

Study A deals with the volume of sales of independent retail stores and is an example of the use of an incomplete list of stores supplemented by an area sample to cover those stores not on the list. Study B deals with the best known of the Bureau's inquiries, the Current Population Survey, which consists of a monthly sample of 25,000 households designed primarily to provide data about the labour force. Study C describes the estimation procedure used in the Annual Survey of Manufacturers. Essentially it is a difference estimate making use of an earlier census of manufactures. Study D contains some interesting tables giving the variances of various households and personal characteristics, such as income, age and occupation for clusters of 3, 9 and 27 households. Study E describes the sampling plan used for verifying the punching of the 1950 Census.

Volume II contains the theory necessary to derive the formulae in the first volume. This theory which is given in the first eleven chapters covers the ground already covered in recent books

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

but with perhaps greater emphasis on cluster sampling. Chapter 12 discusses briefly the effect of non-sampling errors, the requirements of a mathematical model and the effect of interviewers on the variance.

One may conclude that Volume I should be read by all those engaged in sample survey design. All the necessary formulae are given with sufficient guidance as to how they should be applied. So if the survey worker has only limited funds it would be better to concentrate on Volume I.

P. G. GRAY.

5.—*Exercises in Theoretical Statistics.* By M. G. Kendall. London: Griffin, 1954. vii + 179 pp. 9″. 20*s*.

The last twenty-five years have seen a very great increase in the amount of teaching that is done in statistics, in universities, technical colleges and even schools, with consequent increase in the number and variety of examinations. The examination requirement has led to a need of good exercises for coaching purposes, while at the same time providing the necessary material in examination questions. It is, however, a matter of some difficulty for the average candidate to get hold of past examination questions, added to which many of these are of little use to him unless hints are provided for their solution. From the teacher's point of view, collections of exercises are welcome, and there must be many teachers who are not averse from being provided with the solutions. It so happens that as this need arises, so is it being met. At least three books of this character were published before the present year, dealing with relatively elementary statistical exercises, and providing practical material on which students may exercise their ingenuity.

With great industry, Professor Kendall has endeavoured to meet the needs of a more advanced class of student. Partly original, and partly quoted from the examination papers of various bodies, we have here 400 problems, divided as to 100 on distribution theory, 100 on sampling, 75 on statistical relationship, 75 on estimation and inference, and 50 on time-series. Answers, if not stated in the questions, are given at the end, together with brief hints on how the solution is to be reached. Where there is an examination source, this is stated at the end of the question, but this is not necessarily to be taken as a guide to the difficulty or otherwise of a particular examination, since a single long examination question has in places been split up into two or three exercises, and in at least two places the last part of the official question, believed to be the most interesting and original part of the problem, has been dropped.

There is a certain amount of heterogeneity in the collection, and occasional faults will be found by an industrious reader. But on the whole the author has performed a thankless task admirably, and future generations of statistical students will have cause to be grateful to him for his industry in making this set of exercises available for general use.

J. WISHART.

6.—*50–100 Binomial Tables.* By Harry G. Romig. New York : Wiley. London : Chapman & Hall, 1953. xxvii + 172 pp. 9″. 32*s*.

Tables of the Binomial Probability Distribution were issued in 1950 by the National Bureau of Standards as no. 6 of their Applied Mathematics Series. These were to 7 decimal places, with the index n proceeding by units from 2 to 49, for values of the probablility $p = 0{\cdot}01(0{\cdot}01)0{\cdot}50$, and gave both individual terms and partial sums. At about the same time as these were in preparation Harry G. Romig, then at the Bell Telephone Laboratories, prepared a similar set of tables for n proceeding by 5's from 50 to 100, to 6 decimal places. It is these tables, issued in preliminary draft form in 1947 as a memorandum, which have now been published as one of the Wiley Publications in Statistics. They can be very easily described. For each n block there is a set of tables for $p = 0{\cdot}01(0{\cdot}01)0{\cdot}50$. Each table has three columns ; the first gives the integer x, which can in theory proceed from 0 to n, but is in fact truncated at one or both ends where the individual binomial terms are zero in the table; the second column provides the individual term $\binom{n}{x} p^x q^{n-x}$ corresponding to any x, to 6 decimal places ; while the third gives the cumulative probability of x or less, namely $\sum_{m=0}^{x} \binom{n}{m} p^m q^{n-m}$, also to 6 decimal places.

The arrangement is an improvement on the tables of the National Bureau of Standards, and consultation is helped by the bold index figures for n in the outside margin, and by the clear headings for the different values of p. For the rest, the table is a useful supplement to the earlier-published table, beginning where the former leaves off. A minor disadvantage of the scheme is that only every fifth integer in n is covered. Some reference is made in the introduction to methods of interpolation using known relations for the incomplete Beta-function, but for more details about interpolation generally we are referred to a companion volume to be issued. The introduction goes

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

into painstaking detail on how to look up the table, including values for $p > 0{\cdot}5$. The table is produced by a photographic process; the figures are on the small side, and there are minor irregularities due to making corrections in an existing manuscript, and to using two typewriters. There is also a certain amount of smudginess. There is no reason to suppose, however, that the tables are not accurate, which is what really matters, and they should be useful to those who require high order binomial terms and their sums. J. WISHART.

7.—*Tables of* 10^x (*Antilogarithms to the Base* 10). National Bureau of Standards Applied Mathematics Series, 27. Washington: Government Printing Office, 1953. viii + 543 pp. 10″. $3.50.

Table of Natural Logarithms for Arguments between Zero and Five to Sixteen Decimal Places. National Bureau of Standards Applied Mathematics Series, 31. Washington: Government Printing Office, 1953. x + 501 pp. 10″. $3.25.

The Table of Antilogarithms is a new table which will be a welcome accession to the comparatively small number of existing fundamental logarithmic tables to many decimals. The main Table I covers exactly 500 pages. For x ranging from 0 to 1 at intervals of ·00001, we are given 10^x to 10 decimal places. No differences are provided. In fact the second differences are of the order of 5 at the beginning and 50 at the end of the table, in units of the last decimal. Thus, as stated, linear interpolation will give nine-decimal place accuracy, and with ordinary machine methods does not require the tabulation of first differences. An auxiliary correction "schedule" is provided in the introduction for those who want full ten-decimal accuracy. The antilogarithms are very clearly set out, in columns. The basis for the table is stated to be the *Antilogarithmic Canon* of J. Dodson, published in London in 1742. This table is now very scarce, is inconveniently arranged, and has a large number of errors. The present table was prepared from Dodson, machine methods enabling extensive differencing to be done in order to check for errors. The reputation of the National Bureau of Standards in table-making is such that the user should be confident of accuracy throughout the whole range.

The subsidiary Table II is a table of 10 to the power $n/10^p$, for the integers n from 1 to 999, and for $p = 3$, 6, 9, 12 and 15, to fifteen decimal places. The table is used to find the antilogarithm of a decimal number given to as many as fifteen places, by breaking these up into threes and finding the appropriate antilogarithms which are then multiplied together.

The second table under review is a reprint of the third of the four-volume tables of logarithms issued in 1941 by the New York Mathematical Table Project. It is a straightforward table of 500 pages, giving the natural logarithm of x, to sixteen decimal places, for values of x proceeding from 0 to 5 at the fine interval of 0·0001. It will interest English readers to hear that a check on accuracy was made by using 80,000 entries from Thompson's *Logarithmetica Britannica*, and not a single error was found in either of the two tables. J. WISHART.

8.—*External Migration: A Study of the Available Statistics*, 1815–1950. By N. H. Carrier and J. R. Jeffery. (General Register Office: Studies on Medical and Population Subjects.) London: H.M.S.O., 1953. 163 pp. 8*s.* 6*d.*

The study of statistics of migration to and from the United Kingdom has always been difficult owing to the diversity of the material available, the number of authorities and sources dealing with the subject and the changes in scope and methods of compilation of the data. No annual reports on British migration exist such as exist in the Commonwealth countries, the U.S.A. and other important migration countries and the student has to rely on articles in the *Board of Trade Journal*, reports of the Ministry of Labour and National Service, the Home Office, and other sources. It is therefore to be welcomed that the General Register Office has devoted one of its studies on medical and population subjects to the subject of external migration. The aim of this study, it is stated, is "to bring together in a convenient form a vast mass of unco-ordinated material which has been built up over the years, on the volume and characteristics of the migrating population of the past", and the authors have succeeded fully in this aim. Continuous statistics (with breaks for war-years) are given from 1815 to 1950. The origin of the statistics of emigrants from the United Kingdom is the Act of 1803 under which muster rolls of passengers had to be prepared by ships' masters with the object of ensuring that the quantity of food and drink carried was sufficient for the voyage. No statistics, however, have been found earlier than those for the year 1815.

After discussing the data on migration which can be deduced from population census records, the authors describe the direct data obtainable from port and transport records. Early statistics failed to distinguish between passengers and emigrants (i.e., those leaving for a change of residence)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and data on immigrants were scrappy or non-existent. The various bodies entrusted with the task of collecting information, from the Colonial Land and Emigration Commission (1840–1872) down to the present authorities (Board of Trade, Ministry of Labour and Home Office for aliens), and the changes in legislation and regulations are fully described.

Three chapters are then devoted to the statistical data. The first, a "Century of Emigration" covers the years 1815–1914; the second, the inter-war period 1918–1939; and the third, the post-war period 1945–1950. The data are then analysed according to characteristics of migrants (i.e., sex, age, and occupation) and a final chapter is devoted to alien migration and the changes brought about in this sphere by the two world wars. Elaborate tables are given both in the text and in a special appendix; and references given in each case to the sources of the data and the methods of compilation (set out in other appendices). A large number of diagrams add to the value of the tables.

In a final appendix, estimates are made of the population of England and Wales in 1960, 1970, 1980 and 1990 on certain assumptions as to mortality and natality and on five different assumptions on the volume of migration. Assuming no migration the estimated population is 46,424,000 in 1990; assuming emigration of 100,000 males aged 15–40 annually for 20 years, the estimate (the maximum) is 44,767,000.

This report is a valuable and readable contribution to the migration history of the United Kingdom and fills a long-felt want.

J. W. Nixon.

9.—*Social Accounts of Local Authorities: An Experiment in Sampling Methods.* By J. E. G. Utting. National Institute of Economic and Social Research; Occasional Paper XVI. Cambridge: University Press, 1953. x + 89 pp. 9½″. 16*s*.

This is an intriguing study; interesting and important in both method and results. Social accounting, the construction of a system of accounts showing the transactions taking place between and within the various constituent sectors of an economy is now generally accepted as an essential requirement of economic analysis. Particularly is this true in connection with the formulation of economic policy. Systems of social accounts are still, however, far from being as complete, comprehensive, or detailed as is desirable. Mr. Utting's work on the local government sector makes a most significant contribution here. It is yet another example of the lead invariably given to government departments and statisticians by private investigators. Almost every single important development in the official provision of statistical material relating to economic concepts; index-numbers, national income calculations, social accounts, input-output tables, etc.; has followed the path first trodden by private researchers.

Perhaps the most important aspect of Mr. Utting's study is the method used. The value of social and economic enquiry by sample has still not been fully appreciated in this country. Our government departments, particularly, embark on vast, cumbersome, and costly, comprehensive statistical investigations which could be quite adequately carried out on a sample basis.

Inevitably Mr. Utting had to use sampling methods and the importance of his pioneering work in this direction cannot be over-emphasized. Much of the information about local government financial transactions needed for a comprehensive system of social accounts is reasonably well met by normal accounting practice of local authorities and existing returns. The vital matter of a break-down of local authority income and expenditure with respect to other sectors of the economy is, however, not provided for in this way. It was principally here that Mr. Utting's enqiury was so valuable. The most important new information provided related to the remuneration of local government employees.

The procedure adopted was to obtain information concerning transactions in financial years 1946–47, 1947–48, and 1948–49 by questionnaire from a sample of local authorities. The sampling technique, which is described in exemplary detail together with a full discussion of sampling errors, had to take account of the common complicating factor of a response rate well below 100 per cent.; in this case, approximately 50 per cent. A further complication was the wide range in size and importance of local authorities and the absolute necessity of including all the "giants."

While the essential purpose of the enquiry was to estimate the entries in a comprehensive social accounting system for the local government sector, which were not readily available from any existing source, it was clearly necessary and desirable to maintain as close an adherence as possible to concepts and classifications familiar to municipal and county treasurers. We are already moving in this country towards much greater uniformity of local government financial returns. Mr. Utting's study should exert some influence on accounting practice in this field. Indeed it may not be too unrealistic to hope and expect that the social accounts of the local authority sector may ultimately emerge as a fairly readily available by-product of normal methods of financial return.

K. S. Lomax.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

10.—*British Overseas Trade from* 1700 *to the* 1930's. By Werner Schlote. Translated by W. O. Henderson and W. H. Chaloner. Oxford: Blackwell, 1952. xvi + 181 pp. $8\frac{3}{4}''$. 22*s.* 6*d.*

Dr. Schlote's classic work on the development of British foreign trade was first published in Germany in 1938, but owing to the war it was little known in English-speaking countries until very recent years. The present translated edition fills an important gap in the English literature on the subject. It is, moreover, not only a most competent translation; Drs. Henderson and Chaloner have also greatly improved the clarity of the original text in many places by interpolating, in agreement with Dr. Schlote, various useful explanations of the author's train of thought, which—it must be admitted—was not too clear in the original text.

An extremely interesting preface by the German editor, written in February, 1938, points out that Dr. Schlote's book is the first in a series of studies concerning the quantitative development of the British economy which had then been undertaken by one of the research departments of the *Institut für Weltwirtschaft*, Kiel. This important series of studies, which had as its central theme "the long-term development of capitalist economy", was concentrated on British economic development because of Britain's position as the leading industrial power in the nineteenth century. The series included, in addition to Dr. Schlote's work on foreign trade, the well-known study by Dr. Hoffman on the development of British industrial production (*Wachstum und Wachstumsformen der englischen Industriewirtschaft von* 1700 *bis zur Gegenwart*), which was published in Germany in 1940.

Dr. Schlote's book is in two parts. The first deals with the methods used by the author in compiling his various series; the second, after a brief discussion of eighteenth century developments, analyses the movements in British foreign trade from the beginning of the nineteenth century to the mid-1930's.

Quite wrong conclusions had often been drawn from the published statistics for the first half of the nineteenth century, because of the misleading juxtaposition of "declared" export values and the "official" import values which were in use up to 1854 (based on prices ruling at the end of the seventeenth or in the early eighteenth century). Clearly, any serious student of the growth of Britain's foreign trade has first of all to overcome the obstacle of the use of "official" prices in valuation. Dr. Schlote was the first to tackle this formidable problem in a serious way. His method is of some interest. He first calculated what he calls the "volumes" (i.e., values at constant prices) of imports, exports and re-exports each year from 1820 to 1934; the final series (based on 1913 prices) is a linked one based on the results for a number of shorter periods each having its own base year. The results are given in a valuable series of Appendix tables, which distinguish the four main groups of the *Brussels* commodity classification, as well as each of the principal commodities or commodity groups separately. This in itself must have been a gigantic task, but it was only the first stage in the computation (or, rather, estimation) of the true balance of trade for the years before 1854.

Dr. Schlote then constructs a series of estimated "declared" or actual values of imports and re-exports for the years 1801–1854 by applying to his "volume" series the movements shown by Jevons's price index for this period. Dr. Schlote also uses the same method (but with the Sauerbeck, not the Jevons, index) for the period 1854–1934, so as to compare the results with the published figures of the actual value of imports and re-exports; for this later period, the Schlote method gives quite a close fit for imports (apart from the years 1860–1870), but a much poorer fit—as was to be expected—for re-exports. The method can clearly only be expected to give reasonable results for a period in which prices of different commodities, both imported and home-produced, move generally together; otherwise, any substantial shift in the commodity-pattern of the import trade is likely to result in a very significant divergence between a fixed weight *price* index of the Jevons or Sauerbeck type and the *average value* index with moving current weights implicit in the calculation of the volume of imports.

Dr. Schlote's work has, in fact, been severely criticized for this use of a general price index in the estimation of actual values. Professor Imlah, in particular, has gone to great pains (*Journal of Economic History*, 1948) to recompute the actual value of Britain's imports and re-exports from 1798 to 1854, by the use of separate price indices for each of the different commodities. Though he could not apply this more detailed method over the whole field, because of lack of relevant price data, there is no doubt that Professor Imlah's method is much superior to that adopted by Schlote, and the Imlah estimates should be used, rather than Schlote's, for any detailed study of Britain's foreign trade in this period.

However, a detailed comparison of Schlote's estimates of the actual value of (net) imports from 1801 to 1854 with the more "refined" estimates given by Professor Imlah, though it certainly reveals large discrepancies for individual years, nevertheless gives one the impression that the *general* movement over the half-century as shown by the two series was substantially the same. There is little doubt that for the purposes for which Schlote constructed them—the analysis of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the broad movements of Britain's external trade—his estimates of the actual values of imports and re-exports up to 1854 do not seriously distort the picture.

The results of both Schlote's and Imlah's computations show conclusively that the United Kingdom had an adverse balance of merchandise trade over the whole of the nineteenth century (apart from certain individual years in the first two decades). Previous authorities in this field had usually maintained that the United Kingdom went into deficit, on overseas visible trading account, well after the end of the Napoleonic Wars; Stephen Bourne, for example, a great authority on the United Kingdom trade statistics, had calculated the crucial date at about 1825 (*Trade, Population and Food*, 1880). However, the detailed evidence produced by Schlote, and Professor Imlah's later careful work, taken together are quite conclusive on this point. Until very recently, little systematic research had been done on how this trade deficit was met in the early part of the nineteenth century. Professor Imlah's most recent article (*Economic History Review*, 1952), however, gives detailed estimates for each main element in the "invisible" account; even allowing for the inevitably wide margin of error which must surround estimates of this kind, it seems reasonable to conclude that earnings from shipping and other invisibles were generally sufficient, not only to offset the adverse balance of visible trade, but also to allow for net investment abroad for the entire period following the Napoleonic Wars.

The second half of Dr. Schlote's book makes some interesting analyses of the results of the statistical exercises described briefly above. There is an interesting review of the trends in United Kingdom imports of food, materials and manufactures. Schlote shows (pp. 56–57) a surprisingly high degree of association between his index of the volume of net imports of raw materials and Dr. Hoffmann's index of industrial production. For 1818–1820, the former index is 8·1 and the latter 7·7; for 1911–1913, the indices are 93·5 and 96·6, respectively (1913 = 100). Schlote manipulates the indices for the 1920's and 1930's, by excluding fuels, so as to make them move closely together in this period also. One gets the impression that Schlote is proving too much in trying to "vindicate" his calculations in this way. There is no reason to expect such a close relationship between imports of materials and industrial production over a long period, especially over a period in which the relative importance of the metals and engineering industries (with a low import content) was growing, while that of the textile industries (with a high import content) was diminishing. Certainly, if one compares, say, 1938 with the present time, there has been a marked expansion in industrial production per unit of imported raw materials. It may well be the case, therefore, that the Hoffmann index underestimates the expansion in aggregate industrial production in the United Kingdom during the nineteenth century.

The most interesting sections, however, are perhaps those which investigate the changes in the commodity-area pattern of British foreign trade. In a fascinating analysis (pp. 81–88) Schlote traces the growth of United Kingdom trade with "industrial" countries and with "agrarian" countries separately. The most striking feature of the results is the progressive fall in the *proportion* of United Kingdom exports sent to the "industrial" countries after about 1870—this group of countries took some 40 per cent. of our exports in 1870, about 33 per cent. in 1900, 30 per cent. in 1909–1913, and 25 per cent. in 1927–1929 (the latest years in Schlote's analysis). Taking the countries classified by Schlote as "industrial", i.e., the principal European countries plus the United States, the proportion of United Kingdom exports sent to this group had fallen to 19 per cent. by 1938 and in 1950 it was 18 per cent. The industrialization of some of our main overseas markets has clearly been a major influence since 1870 on the structure and area pattern of our foreign trade.

Schlote was careful not to fall into the crude error of regarding industrialization abroad as being necessarily harmful to the *total* value of United Kingdom exports. He shows clearly, for example, how industrialization on the Continent resulted both in an expansion of United Kingdom exports to Continental industrial countries, and also in an increase in the proportion of raw materials in the total export figures.

The process of industrialization has now become much more widespread than when Schlote was preparing his study in the 1930's. The sharp deterioration in the terms of trade of the primary-producing countries during the 1930's, and the supply difficulties encountered during the Second World War, were powerful stimuli to the establishment or expansion of a great variety of secondary industries in these countries. In many of these countries, the new industries were—and still are—protected by heavy tariffs or quantitative import restrictions. This development, associated with the determination of many "agrarian" countries to embark on schemes of capital investment, has changed the whole character of world demand for imported manufactured goods, and is inevitably having a profound effect on the character of the United Kingdom's export trade. Though much of the merit of Schlote's analysis lies in his perception of the importance of the process of industrialization in Europe and the United States, he appeared to believe that industrialization would not spread to the "agrarian" countries (footnote, p. 82). Though this belief was mistaken, Schlote's

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

work forms an admirable basis for any new studies of the impact of the industrialization of the primary-producing countries on the structure of international trade. A. MAIZELS.

11.—*A Study in Trade Cycle History*, 1833–42. By R. C. O. Matthews. Cambridge: University Press, 1954. xiv + 228 pp. 9″. 25*s*.

The only unfortunate feature about this otherwise highly commendable piece of empirical research is its title. Mr. Matthews is steeped in the refinements of modern economic theory but seems less familiar with the valuable work which has been done on the so-called "trade cycle" by modern statisticians. That work has left little room for doubt that the "trade cycle" in the sense of a unique period of recurrence is largely a figment of the imagination of economic theorists. So long as the latter are content to work with their theoretical models and job backwards, that is, explain *after the event* why certain movements have occurred, their task is fairly easy. When it comes to using them to predict the future—as experience in the current U.S. recession has made evident—the position is very different. The reason is that the series which they use for their so-called "cycles" can be shown not to contain elements which are strictly periodic functions of the time, and accordingly the word "cycle" is best avoided.

As Professor M. G. Kendall observed in his notable paper on the "Analysis of Oscillatory Time-Series", published in the Society's Journal in 1945: "In this sense trade cycles do not, I believe, exist; but there are certainly trade oscillations. The distinction is much more than a mere matter of words. Anyone who believes in the trade cycle must also believe that its recurrences can be closely predicted, whereas one who recognizes trade oscillations may nevertheless consistently hold that the prediction of crises is impossible save within very wide limits". Once it is appreciated that these so-called "cycles" are, in essence, primarily groups of oscillations in a process of growth, they take on an entirely different character. Their amplitudes and forms, for instance, will depend amongst other things on whether the system as a whole in which growth is taking place is a reasonably stable one or whether it is expanding or contracting in size. There is in real life no such thing as steady and continuous growth: always we find periods of acceleration alternating with periods of deceleration. Not only are the main operative factors not necessarily the same in all oscillations, but even when they are the same, the proportions and order in which they operate can vary widely and this may have a significant effect on the final result. To attempt to measure their periods by taking the mean-distance between peaks or between troughs can only lead to gross error and confusion, as Professor Kendall made clear in his paper. The concept of a unique period of recurrence needs to be replaced by that of a distribution of periods, always remembering that it is crises and depressions at their worst which arouse the greatest public interest and which call for the use of shock absorbers.

It is a great tribute to Mr. Matthews that he has not allowed his mastery of the refinements of recent economic theories to cloud his study of the facts. These are allowed to speak for themselves and in so doing to reveal that in effect there was no such thing as a "trade cycle" during the ten-year period of 1833–42 he investigated, only a collection of growth oscillations due to a variety of factors which he enumerates in fairly considerable detail.

Mr. Matthews seems to have been somewhat disconcerted by this discovery for he feels compelled from time to time to apologize for the failure of his material to conform to theory. For example, when referring to the chronology of the several phases of his "cycle" he finds it necessary to point out that the prolonged delay in the return to a satisfactory state of trade after 1825 was inconsistent with "normal cyclical experience" (p. 203): the beginning of work on several railway schemes in the early eighteen-thirties should be regarded as a "non-cyclical phenomenon" (p. 204): and finally that the picture which emerged from the fluctuations of the British economy in his period as a whole differed in certain outstanding respects from "customary views of the trade cycle" (p. 219). Fortunately Mr. Matthews' aberrations about the trade cycle do not in any way mar the value of his work which may be described as a skilful blending of economic analysis with economic history—the "quantitative-historical" is the name he gives to his method of approach. Besides, by arranging his material by subject instead of chronologically he makes it easier for the reader to appreciate that his facts do not fit neatly into any theory. Only in the last chapter is any attempt made to provide a chronological review of the period as a whole in its several phases.

The first seven chapters cover various features of Britain's overseas trade including the balance of payments. These are followed by three chapters dealing with selected industries, including railways, building and shipbuilding, and then a penultimate one on money and banking. Mr. Matthews has handled his material with such adroitness and absence of jargon that even those with a limited knowledge of economic theory should be able to benefit from a study of his book which, incidentally, gives full weight to fortuitous influences which are ignored by economic theory. What still remains to be done is to assess the importance of the oscillations revealed to the long-run evolution of the British economy during the nineteenth century. R. GLENDAY.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

12.—*Welsh Economic Statistics: A Handbook of Sources* . . . By Anne Martin and J. Parry Lewis. University College of S. Wales and Monmouthshire, Cardiff, 1953. iv + 96 pp. $12\frac{3}{4}''$. 8*s.* 6*d.*

Workers on economic and social conditions in Wales have long felt the need of guidance with regard to the sources and nature of statistics relating to the Welsh economy. Officially published statistics have usually treated England and Wales as a unit, while often furnishing separate statistics for Scotland and Northern Ireland. The position in Wales is complicated because though the Welsh regions of the main government departments are identical the boundaries used by the Post Office, the Gas Board, the British Electricity Authority and the National Coal Board, to mention but a few, do not coincide.

During recent years there has been a tendency to treat Wales separately in this statistical context, as exemplified in the *Ninety-fourth Report of the Commissioners of Her Majesty's Inland Revenue for the year ended* 31*st March*, 1952 (January 1953, Cmd. 8726) and in the 1949 Census of Production Tables. It is to be hoped that this movement towards a dichotomy of officially published statistics for England and Wales will continue, both in view of possible devolutionary trends in government and as an aid and stimulus to investigators of Welsh economic and social problems. On geographical, economic, sociological and cultural grounds Wales emerges as a distinct region. The growing economic significance of studies in the national income, of variations in its amount and allocation through time, further tell in favour of this dichotomy.

The *Handbook of Sources of Welsh Economic Statistics* now made available should prove an invaluable help to economic and social investigators of Wales. The sources are detailed under appropriate subject headings, viz., Population; Vital Statistics; Housing and Households; Health and Welfare; Industrial Injuries and Welfare; Production; Electricity and Gas; Employment and Unemployment; Earnings and Wage Rates; Development Areas and New Industry; Ports, Docks and Canals; Agriculture, Forestry and Fishing; Co-operative Society Statistics; Distribution; Taxation; Finance, Insurance and Building Societies; Post Office; Roads and Road Vehicles; Water Supply and Sewerage; Local Government, Police Force and Fire Service; Sundry Social Services; Education. The tracing and sorting of such a variety of sources must have proved no mean task. The coverage is good; in addition to central and local government sources of information there are numerous references to the publications of trade unions and professional bodies. An index to the sources would have facilitated speedy reference.

However, the publications enumerated are not readily at hand or easily accessible to the majority of investigators. This points to a highly desirable objective, namely, the provision of an official Digest of Welsh Economic Statistics. It is significant that the *Digest of Scottish Statistics* (No. 1, April 1953. Edinbrugh, H.M.S.O., 1953) will now be available bi-annually, and will include indices of quarterly changes in the industrial production of Scotland.

The authors are to be congratulated on making available for the first time a well-ordered set of references to the sources of economic statistics relating to Wales. They will have left many students under a debt of gratitude to them.

PERCY GEORGE.

13.—*Bristol on the Move.* London: British Transport Commission. 1953. 40 pp. 9″. 10*s.* 6*d.*

This book reports a travel survey carried out on behalf of the British Transport Commission by Research Services Ltd. in the winter of 1950–1 covering the city of Bristol and some of the surrounding districts. Any appraisal of the book must, therefore, be in two parts, the first concerned with the presentation and the second with the methods of the survey.

The book is said to be presented to three different interests: sociologists, transport operators and advertisers. Since it has only 40 pages, of which 6·5 are either blank or display headings, and 13 are devoted to photographs, only half of the space is available for presentation of data or information. This, divided between the three separate interests forming the target audience results in some rather thin coverage, adequate perhaps for some purposes but likely to prove frustrating to the social statistician. Tables are provided showing the characteristics of people who made journeys, the purposes of these journeys, the time of bus journey stages, the cost of public transport journeys and the like, but there is no mention of the distance travelled, there are no flow maps, nor is there any indication of the relationship between transport and amenities such as shops, cinemas and public buildings, and no consideration of the special problems of re-housed communities a distance from the town.

The limitation to public transport users in most of the tabulations is perhaps unavoidable, but it means that a picture of the movements of Bristol population is not available. Sometimes the restriction of the data to public transport users and usages is not very clearly made in the table

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

headings, for example, one table is headed "Average weekly cost per household of journeys . . ." From this table it appears that the middle income groups spent most on travel, and this fact is repeated in the text. It is not pointed out that in all probability the upper income groups spent most on travel if taxi fares and the cost of private cars were included. A better heading for the table (and others) would be "Average weekly expenditure on public transport . . ." or some other form which made the table quite clear in its limitation.

There are also some points of detail in the presentation which may reflect upon the methods used in the field. In particular it is noted that there are groups for "information not obtained" in almost all tables, including age and time taken by journey; there is no "not stated" group for income grade. This is rather odd, because it is surely easier to obtain information regarding age than income from British households? It is also to be noted that industry and occupation are confused.

Turning now to the method used in the study. The sample design seems to have been quite good apart from a small error, but it is surprising that only 75 per cent. of the originally selected addresses were interviewed, and a further 2 per cent. were rejected "for one reason or another" at the editing stage. 11 per cent. were cases of refusal to be interviewed, and 10 per cent. were cases where an investigator was unable to make a contact.

Although only a small point, the error in the sampling design should be stressed since it shows an incorrect method of thinking about some aspects of random sampling. Where the sampled address contained more than one household, the investigators interviewed up to three, no deletion procedure was adopted. But the authors set out to show that they are aware of the normal deletion procedure and state that this is to delete (when a multiple household address is encountered) the next "address on the working list at which no interview has yet been obtained". This, they state meets the theoretical requirements. In fact it does not, as the deleted address must be one which has not been called upon, nothing may be known about the address deleted and an abortive call provides information. The authors also state that "in practice the effect of deleting addresses is to diminish the geographical spread of the sample". This also is not true.

This book reports the second survey to be carried out in this country into travel habits, and its publication is therefore to be welcomed. Indeed the main criticism must be that more was not published even at the expense of cutting out photographs and reducing considerably the almost blank display pages.

LESLIE T. WILKINS.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

The interim index of retail prices published by the Ministry of Labour and National Service remained stationary at 140 (prices at June 17th, 1947 = 100) in December, January and February and rose to 141 in March. Although the index on average showed little movement there were increases during the period in the prices of certain food items, notably green vegetables, cooking apples, butter and tea, and decreases in the case of eggs. There were also increases in the price of coal in some areas. Separate figures on the same basis for different groups of commodities are not available, but the following are the figures based on January 15th, 1952 = 100.

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*House-hold Durable Goods*	*Miscel-laneous Goods*	*Services*	*Alco-holic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
Dec. 15th, 1953	109·6	109·8	96·3	110·5	95·9	100·0	109·5	101·4	100·3	105·6
Jan. 12, 1954	110·2	109·9	96·1	110·7	95·6	100·0	109·5	101·5	100·3	105·8
Feb. 16th, 1954	109·5	110·1	96·3	111·1	95·6	99·9	109·6	101·5	100·3	105·6
March 16th, 1954	111·6	110·3	96·3	112·0	95·6	100·0	109·7	101·5	100·3	106·6

The Ministry of Labour index of weekly wage rates, which was 138 (June 30th, 1947 = 100) in December rose to 139 in each of the following three months. The principal classes of workers whose wage rates were increased during the period included those engaged in the road transport of goods, employees of omnibus undertakings, builders and railway workers. There were also increases in the national minimum rates for coal miners.

The six-monthly enquiry into average earnings showed that in October, 1953, the average earnings per week in the industries covered by the inquiries were 189*s.* 2*d.* for men, 102*s.* 5*d.* for women, 78*s.* 11*d.* for youths and boys and 64*s.* 11*d.* for girls. These figures represent increases over October, 1938, of 174, 215, 203 and 251 per cent. For all workers combined the average was 160*s.* 1*d.*, an increase of 201 per cent.

The index for October, 1953, compared with 100 at April, 1947, was 155. This compares with a wage *rate* index for the same industries of 138. The average hours worked in October, 1953, were 46·3 (47·9 for men only). This was slightly more than at the same date in 1952 and equals the figure recorded in April, 1951, the highest since 1946. In manufacturing industries alone the average earnings in October, 1953, were 196*s.* 7*d.* for men and 103*s.* 2*d.* for women.

The same enquiry showed that in all the industries covered 32 per cent. of the wage-earners were paid under systems of payment by results in October, 1953. This compares with 25 per cent. in 1938. In the case of men the percentage was 29 compared with 18 but for women it was 42 compared with 46. In manufacturing industries alone the percentage for men rose from 29 in 1938 to 38 in October, 1953, and for all workers combined from 33 to 40.

The total working population and the numbers in civil employment in the four months ended February, 1954, were as follows:

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Nov., 1953 .	15,945	7,630	23,575	14,906	7,494	22,400
Dec., 1953 . .	15,920	7,554	23,474	14,872	7,416	22,288
Jan., 1954 . .	15,947	7,549	23,496	14,882	7,406	22,288
Feb., 1954 . .	15,930	7,533	23,463	14,878	7,395	22,273

The number of persons on the unemployment registers of the Employment Exchanges rose by 65,000 between December and February and fell by 45,000 in March. The total of 342,866

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

at March 15th represented 1·6 per cent. of the estimated total employees in Great Britain. The percentages in the separate Regions ranged from 0·7 in the Midlands and North Midlands to 2·7 in the Northern Counties, 2·8 in Wales and 3·3 in Scotland.

The following is a sex analysis of the figures.

Numbers of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
Dec. 7th, 1953 . . .	207,466	114,327	321,793
Jan. 11th, 1954 . . .	244,927	127,929	372,856
Feb. 15th, 1954 . . .	261,663	125,640	387,303
March 15th, 1954 . .	224,138	118,728	342,866

Of the total of 342,866 at March 15th, 84,918 had been unemployed for not more than 2 weeks, 85,245 for 2 to 8 weeks, and 156,356 for more than 8 weeks while 16,347 were temporarily stopped.

Figures showing the estimated number of employees (employed and unemployed) at May, 1953, were published in the *Ministry of Labour Gazette* for February. These showed the total for Great Britain to be 20,880,000 (13,720,000 males and 7,160,000 females). For the United Kingdom the total was 21,347,000 (14,016,000 males and 7,331,000 females). Detailed figures are given for each industry.

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed, were 1,069,700 in January, 1,106,900 in February and 1,007,000 in March. The numbers of employees absent owing to industrial injuries were 64,100, 67,500 and 63,300.

The General Register Office have begun to publish the County Reports based on the 1951 census of England and Wales. Reports for London, Middlesex, Essex, Surrey, Kent, Hertfordshire, Lancashire and Cheshire have already appeared and others will have been published before this note is in print. Generally the pattern of the Reports is similar to that of the 1931 Reports except in so far as the new questions asked in 1951 on household arrangements and education require additional tabulations, and there is more detailed information about private households arising out of the tabulations of heads of households. In addition, material relating to birthplace, nationality and social class which in 1931 was given in the General Report is included in the 1951 County Reports. On this occasion the textual discussion of the tables is more extensive and informative and there are more summary tables embodied in the text.

The main sections are

1. *Population changes.* Discussion of intercensal trends, migratory movements (including special features during the 1939–45 war), the development of dormitory areas adjacent to industrial or commercial centres and other special features of population growth in local areas.

2. *Housing.* The main changes in numbers and sizes of dwellings in undivided and shared occupation, as related to changes in numbers and sizes of households. The underlying distributions which are summarized in indices of housing density are deployed in a manner likely to assist those concerned with the measurement of housing needs.

3. *Household arrangements.* Local differences in the availability of piped water, cooking stoves, kitchen sinks, water closets and fixed baths.

4. *Household composition.* Ages and marital condition of heads of households.

5. *Birthplace and Nationality.*

6. *Sex, age, marital condition.*

7. *Education.* Discussion of the numbers attending educational establishments full time, and of the numbers remaining at school beyond the statutory school leaving age.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

8. *Social* (*i.e.*, *occupational*) *class.* Local differences in the proportions of professional or artisan components of the occupied male population throwing some light on the residential or industrial nature of the areas, and on other local variations in the structure of the population.

The addition of a Morbidity Supplement* to the Registrar General's Annual Review represents an innovation of considerable importance. Since the appointment of Farr in 1839, the medical part of the *Statistical Review* has concentrated almost entirely upon a comprehensive and detailed analysis of death certificates, although in recent years the General Register Office has initiated valuable attempts to develop morbidity statistics on a national scale to extend knowledge of public health. This Supplement contains statistics derived from three sources: a general survey of sickness, registration of cancer cases by hospitals, and records maintained in mental hospitals and mental deficiency hospitals. Some material from these sources has already been presented in other publications (for example, *General Register Office Studies on Medical and Population Subjects*, Nos. 2 and 3), and though the 1949 supplement contains more detail than it has previously been possible to publish, it is the promise of regular publication rather than the contents of this supplement which is of most significance.

The Survey of Sickness provided data about the number of people who were ill, the numbers of illnesses they suffered from, the days of incapacity they experienced, and the number of times they consulted their doctors. The figures published show how these numbers were affected by exceptional weather conditions, the influenza epidemic early in 1949 and the introduction of the National Health Service in 1948. Some 85,000 people were asked about their sickness experience in the course of the two years 1948 and 1949.

The tables show for 1949 the ages of the people affected by sickness, the regions of the country they lived in, the type of job they were in, their income group and the kind of sickness they suffered from. For example, on the average there were 167 sicknesses (including comparatively minor ailments) reported per month for every 100 persons interviewed in the Northern Region, compared with 148 sicknesses for every 100 persons in the South East Region, and male agricultural workers reported 97 sicknesses per month for every 100 interviewed, compared with 131 sicknesses for miners. The Survey was suspended in 1952. It is to be hoped that some alternative general measure of morbidity will before long be found to take its place. The General Register Office are known to be experimenting with the analysis of general practitioners' records and these may eventually fill some part if not all of the gap.

The part of the volume devoted to mental health presents a statistical account of the 58,497 admissions to mental hospitals and mental deficiency institutions in 1949, the 55,723 discharges and deaths and the 171,969 patients who had been resident throughout the year. The tables show the age and marital condition of patients in relation to the diagnosis of their mental illness and the duration of their stay in hospital. About 70 per cent. of the admissions to mental hospitals were in the more serious psychotic group of conditions; the problem of old people in these hospitals is underlined by the fact that 28 per cent. of those resident at the end of 1949 were aged 65 or over, and the changing attitude of the public to the hospitals is reflected in the fact that 60 per cent. of admissions were voluntary patients.

Not all hospitals yet register cases of cancer which come to them for treatment, but the national registration scheme covers a larger number of cases each year than has been covered in other series of cancer statistics. Figures are given of the number of cases registered in 1947 and 1948, showing, for each site of cancer, the sex and age of the patients. Altogether 89,443 cases were analysed in this way. Figures are also given of the reported duration of symptoms before treatment was started.

Digest of Scottish Statistics, *No.* 1, *April*, 1953 (Scottish Home Department, Edinburgh, H.M.S.O.).—Compiled on the same lines as the *Digest of Statistics* for the U.K. this half-yearly publication provides a detailed analysis of the Scottish economy. Of particularly interest is the Index of Industrial Production, showing progress over a wide range of industries in Scotland. It is planned to include new statistics as these become available, the present range being necessarily limited to those fields for which separate Scottish figures are recorded.

* *The Registrar General's Statistical Review*, 1949, Supplement on General Morbidity, Cancer and Mental Health, H.M.S.O., price 7*s.* 6*d.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Economic Commission for Europe has issued under the title *Economic Survey of Europe in* 1953 *including a Study of Economic Development in Southern Europe* (314 pp.), its seventh annual report. Of the three main parts, the first two on Western Europe, and on the Soviet Union and East Europe follow largely the lines of previous reports, the third is devoted this year to Southern Europe (by which is meant Turkey, Greece, Yugoslavia, Southern Italy, Spain and Portugal) in pursuance of resolutions of the 8th session of the Economic Commission. This part gives first a monograph on each of these countries under the title Retarded Development of Southern Europe followed by a chapter on the Achievement and Potentialities in Main Branches of Production and one on Some Key Problems of Economic Development in Southern Europe. A lengthy article would be required to summarize the conclusions of this report and its proposals on the possibilities of expanding and accelerating the developments of the less-developed countries of Southern Europe. As in previous reports, the valuable statistical tables and their detailed discussion in an appendix are an outstanding feature.

A report prepared jointly by the secretariats of the Economic Commission for Asia and the Far East, the Economic Commission for Europe and the Food and Agricultural Organisation entitled *A Study of Trade between Asia and Europe* (145 pp.) has recently been issued. It analyses the situation from the points of view of exports from, and imports into Asia and the Far East and considers the methods by which Europe can assist the Asian countries to develop and to improve their living standards. It suggests three types of "desirable adjustments of world trade and payments". The first is an increase in exports from Asia to the U.S.A. combined with a smaller increase in imports from the U.S.A., the dollar surplus resulting to be used for larger Asian purchases in Europe; the second, an increase in Europe's earnings in the dollar area, with a simultaneous shift in Europe's import of raw materials from dollar sources to Asia; and the third, much greater capital movements to supplement merchandise balances. Over half of the report consists of "commodity appendices" which discuss market trends and prospects for a series of Asian products (rice, tea, oils and oilseeds, rubber, tin, jute, carpet wool, etc.) and of a series of statistical tables showing, by commodity, imports to and exports from the Asian countries, as well as trade between Asia and the U.S.A. The development of international trade between Europe and the countries of the Asian continent, though hampered at present by the political situation, is one of world-wide interest, and this objective report is an outstanding contribution to the subject.

CURRENT NOTE

The Trustees of the Houblon-Norman Fund, on the recommendation of their Advisory Committee, have made the following awards for 1954–55.

Fellowship.—Mrs. A. M. Millard, Lecturer, Battersea Training College, "London's Imports 1600–1640".

Research Grants.—Mr. G. Clayton, Lecturer, University of Liverpool, "The Present Organisation and Structure of the Swedish Banking System"; Mr. R. E. George, Statistical and Administrative Assistant, South Western Gas Board, "Economic Policy in the Gas Industry before Nationalisation"; Mr. N. J. Gibson, Research Student, The Queen's University of Belfast, "Banking in Ireland"; Mr. D. M. Joslin, Fellow of Pembroke College, Cambridge, "Eighteenth Century London Banking 1720–1826"; Miss S. M. Knight, Research Assistant, "The Structure and Problems of Banking in Belgium"; Miss D. M. Knox, History Mistress, Ursuline Convent, Brentwood, "London Brewing Trade 1830–1914"; Mr. R. V. Lennard, Historian (Renewal), "Rural England in the Feudal Age"; Mr. F. J. Parker, Midland Bank Ltd., "Banking in Hertfordshire"; Professor J. H. B. Tew, Professor of Economics, Nottingham University, "Institutional Finance of British Industry"; Mr. L. Wilks, Chase National Bank of the City of New York, "Economic Consequences of the Growth of Pension Schemes and Superannuation Funds"; Mr. T. Wilson, Fellow of University College, Oxford (Renewal), "Economic Fluctuations in the United Kingdom between 1923 and 1938".

An offer of awards for 1955/56 will be made in due course. Further information may be obtained from the Secretary, Houblon-Norman Fund, c/o Bank of England, London, E.C.2.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

October 1953—The finance of public companies—an exploratory study of two industries: *A. Luboff*. Income and capital in income taxation—distributions by companies: *H. Edey*. The mathematics of variance analysis and the possibilities of its application: *K. C. Banerjee*. The formal principles of public company accounting: *F. Sewell Bray*. The distinction between sub-accounts and the sides of an account: *M. N. Monteiro*.

January 1954—Recent developments in national income and social accounting: *M. Gilbert* and *R. Stone*. Net taxable wealth, income and age of directors and executive directors of larger Swedish companies: *G. Lindgren*. The mathematics of variance analysis. III. The theory of N variance systems: *G. Amerman*. The valuation of goodwill: *J. Tayleur*.

Advancement of Science—

March 1954—Cybernetics: *E. C. Cherry*, *W. E. Hick* and *D. M. Mackay*. Society and the calculating machine: *L. Rosenhead*, *A. Fletcher* and *A. Young*.

Annals of Eugenics—

January 1954—Studies on linkage in man. Red hair versus blood groups, P.T.C. and eye colour: *M. Hauge* and *H. F. Helweg-Larsen*. Physico-chemical study of human iso-haemagglutination: *S. Filitti-Wurmser*, *Y. Jacquot-Armand*, *Y. Aubel-Lesure* and *R. Wurmser*. The relative aetiological effects of maternal age and parity in binovular twinning: *N. McArthur*.

March 1954—The separation of the sexes of parents in the detection of linkage in man: *C. A. B. Smith*. On the theory of random mating: *J. H. Bennett*. Note on the inheritance of the Duffy blood-group system and its possible interaction with the rhesus groups: *J. Mohr*. β-Aminiosobutyric acid excretion in urine. A family study in an Italian population: *C. Calchi-Novati*, *I. B. Cepellini*, *E. Silvestroni* and *H. Harris*. A test for skewness with ordered variables: *F. N. David* and *N. L. Johnson*.

Biometrika—

December 1953—The population frequencies of species and the estimation of population parameters: *I. J. Good*. Capture-recapture analysis: *J. M. Hammersley*. The use of chain-binomials with a variable chance of infection for the analysis of intra-household epidemics: *N. T. J. Bailey*. Spread of diseases in a rectangular plantation with vacancies: *G. H. Freeman*. Tests of significance for concurrent regression lines: *E. J. Williams*. Approximate confidence intervals. II. More than one unknown parameter: *M. S. Bartlett*. Non-normality and tests on variances: *G. E. P. Box*. Approximating to the distributions of measures of dispersion by a power of χ^2: *J. H. Cadwell*. The power function of some: tests based on range: *H. A. David*. Some simple approximate tests for Poisson variates *D. R. Cox*. Orthogonal polynomial fitting: *J. Wishart* and *T. Metakides*. Population differences between species growing according to simple birth and death processes: *J. H. Darwin*. Modifications to the variate-difference method: *M. H. Quenouille*. Moments of the rank correlation coefficient in the general case: *R. M. Sundrum*. 99·9 and 0·1 per cent. points of the distribution: *T. Lewis*. Tables of symmetric functions. Part IV: *F. N. David* and *M. G. Kendall*. Some procedures for comparing Poisson processes or populations: *A. Birnbaum*. Scale factors and degrees of freedom for small sample sizes for χ-approximation to the range: *G. W. Thomson*. The third moment of Gini's mean difference: *A. R. Kamat*. A method of systematic sampling based on order properties: *R. M. Sundrum*. A note on ordered least-squares estimation: *F. Downton*. A note on the evaluation of the multivariate normal integral: *F. N. David*. A graphical method for the analysis of statistical distributions into two normal components: *E. J. Preston*. A note on regions for tests of kurtosis: *G. E. P. Box*. The frequency justification of sequential tests—addendum: *G. A. Barnard*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

British Journal of Preventive and Social Medicine—

January 1954—The changing pattern of mortality in England and Wales. I. Infant mortality: *Wallis Taylor*. Design of records for field work: *L. Hogben* and *K. W. Cross*. Incidence of infectious diseases in the first three years of life, related to social circumstances: *C. R. Lowe* and *T. McKeown*. A survey of mental hospitals and mental deficiency institutions in the Birmingham region. I. Mental hospitals: *K. W. Cross*.

British Journal of Sociology—

December 1953—Rising eighteen in a London suburb: *R. F. L. Logan* and *E. M. Goldberg*. Aristocracy and the Middle Class in the British political elite, 1886–1916: *W. L. Guttsman*. Attendance in the coal mining industry: *F. D. K. Liddell*.

Cambridge Philosophical Society, Proceedings—

January 1954—The asymptotic distribution of serial correlation coefficients for autoregressive processes with dependent residuals: *A. M. Walker*.

Economic Journal—

March 1954—Supply functions in Keynesian economics: *F. J. de Jong*. The interpretation and application of the compensation principle: *N. J. Bailey*. The relation of economic growth and cyclical fluctuations: *N. Kaldor*. Development charges and the compensation-betterment problem: *D. L. Munby*. Further notes on economic progress and occupational distribution: *P. T. Bauer* and *B. S. Yamey*. Studies in national income and expenditure: *R. G. D. Allen*.

Eugenics Review—

January 1954—Personality differences and neurotic traits in normal twin schoolchildren: *J. Shields*.

Geographical Journal—

December 1953—The geographical pattern of population changes in England and Wales, 1921–1951: *E. C. Willatts* and *G. C. Newson*.

Incorporated Statistician—

December 1953—The work of the Central Statistical Office: *H. Campion*. International statistics for governments: *M. P. Rogers* and *J. I. Mason*. Cost calculations for sequential sampling schemes: *D. G. Champernowne*.

Institute of Actuaries, Journal—

Vol. LXXIX, Part III, No. 353—Reproductivity in Great Britain: a new standard of assessment: *P. R. Cox*. Large-scale electronic digital computing machines: *R. L. Michaelson*.

Institute of Actuaries Students' Society, Journal—

March 1954—A standardized bowling ratio: *N. L. Johnson*. Statistical tests of random order: *R. H. Daw*.

Manchester School of Economic and Social Studies—

January 1954—Some aspects of the taxation of companies: *D. Walker*. The task and methods of the Monopolies Commission: *Dame A. Kilroy*. British exports and the scale of production: *J. M. Jackson*

Oxford Economic Papers (New Series)—

February 1954—The trade cycle in Britain, 1790–1850: *R. C. O. Matthews*. Convertibility: *J. R. Sargent*. An experiment in commodity control—the International Wheat Agreement, 1949–53: *C. D. Harbury*.

Oxford University Institute of Statistics Bulletin—

January 1954—The distribution of private capital, 1950–51: *K. M. Langley*. A note on the valuation of British imports: *E. Nevin*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Population Studies—

March 1954—The intelligence of urban and rural children: *W. G. Emmett.* Intelligence and family size: *I. Th. Papavassiliou.* Theory of population and modern economic analysis. II: *A. T. Peacock.* Immigration of Africans into the British Caribbean: *G. W. Roberts.* Population policy in France: family allowances and other benefits. I: *C. Watson.*

Royal Meteorological Society, Quarterly Journal—

January 1954—Computation of tendencies and vertical motion with a two-parameter model of the atmosphere: *F. H. Bushby* and *M. K. Hinds.*

INDIA—

Sankhyā—

September 1953—Some observations on the process of growth of national income: *P .C. Mahalanobis.* The estimation of two parameters from a sample: *J. B. S. Haldane.* Sequential discrimination: *C. L. Mallows.* On transformations useful in the distribution problems of least squares: *C. R. Rao.* On the moments of stochastic integrals: *A. P. Calderon* and *H. B. Mann.* The economics of one-stage stratified sampling: *T. Dalenius.* On certain extended cases of double sampling: *K. C. Seal.* Significance level of $\Sigma x^2/(\Sigma x)^2$ based on Student's distribution: *J. M. Sengupta.* Whither statistics?: *H. Sinha.*

UNITED STATES—

American Economic Review—

December 1953—Mathematical or "linear", programming: *R. Dorfman.* Vertical equilibrium—quality competition: *L. Abbott.* "Full employment", 1955–1960: *R. S. Weinberg.*

American Statistician—

December 1953—Statistics and social forces: *S. A. Rice.* The review and co-ordination of data collecting agencies sponsored by the Federal Government: *H. Alpert.* Extent and character of errors in the 1950 census: *A. Ross Eckler.* Report of ASA Advisory Committee on statistical policy to the Bureau of the Budget.

Estadistica—

December 1953—Mark sensing the Canadian Census records: *R. Ziola.* El censo de población de la Colonia Bethania, Guatemala, Marzo 1953: *V. Secaira E.* Basic agricultural statistical methods: *C. F. Sarle.* Large-scale electronic tabulating equipment in use at the U.S. Bureau of the Census: *J. L. McPherson.* El Centro Interamericano de Bioestadística Chile: *H. Romero.*

Mathematical Tables and other Aids to Computation—

October 1953—Computing eigenvalues and eigenvectors of a symmetric matrix on the ILLIAC: *R. T. Gregory.* A numerical analyst's fifteen-foot shelf: *G. E. Forsythe.* On finding the characteristic equation of a square matrix: *E. Saibel* and *W. J. Berger.*

Quarterly Journal of Economics—

November 1953—The case for accelerated depreciation: *E. D. Domar.* Classical theory, Graham's theory and linear programming in international trade: *T. M. Whitin.* Full capacity *v.* full employment growth: *H. Pilvin.*

Review of Economics and Statistics—

November 1953—On the American economy in 1960. I. Projection, prediction and precariousness: *K. E. Boulding;* II. Growth and stability: *S. H. Slichter;* III. Long-run and short-run adjustments: *A. H. Hansen.* The secular trend in income distribution by type, 1869–1948: a preliminary estimate: *G. J. Scouller.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

FRANCE—

Revue de Statistique Appliquée—

Vol. I, No. 1 (1953)—Le centre de Formation des Ingénieurs et Cadres aux Applications Industrielles de la Statistique: Présentation: *G. Darmois.* Le problème d'organisation—Formation du personnel et liaisons a l'intérieur de l'entreprise: *P. Colin.* Le problème du plan pour l'équipment électrique français: *E. Halphen.* Influence de la vitesse de mise en charge de la machine d'essais sur la résistance à la traction de la fonte: *J. Gélain.* D'un exemple d'application de la carte de contrôle: *J. Mothes.* Méthodes statistiques appliquées dans l'industrie textile: exemples de recherche des causes de variabilité des fabrications, l'analyse de variances: *H. and R. Hodara.* Une expérience pour tester l'aptitude à la dégustation des tabacs: *A. Vessereau.* Simples propos sur l'étude des marchés: *F. Bouquerel*

Vol. I, No. 2—L'application des méthodes statistiques dans l'industrie—Historique de leur développement dans divers pays: *E. Morice.* Sur quelques applications des méthodes statistiques en papeterie: *P. Gillis.* La Service Statistique de la S.A. John Cockerill: *L. Dor.* Introduction des méthodes statistiques dans l'industrie (II)—Mise en route d'un système de contrôle a la réception: *P. Colin.* Plan statistique d'expérience appliquée a la comparaison d'appareils pour la mesure des empoussiérages: *J. L. Soule* and *L. le Bouffant.* Le contrôle précis dans un atelier de frittage (application des méthodes statistiques à l'amélioration d'un procédé de mesure): *M. Guenot.* Aperçus économiques sur l'efficience, le risque et l'investissement: *P. Masse.* Simples propos sur l'étude des marchés: *F. Bouquerel.*

GERMANY—

Allgemeines Statistiches Archiv—

Vol. 37, Part 3—Beklemmungen gegenüber der Statistik in Deutschland: *K. Krieger.* Die Bedeutung der zeitlichen Auswahl bei Erhebungen, insbesondere bei Repräsentativerhebungen: *H. Trustedt.* Über die Anwendung von Stichprobenverfahren zur Kontrolle der Bearbeitung von Kartei—und Erhebungsunterlagen: *H. Zindler.* Die Volkszählung 1953 in Jogoslawien: *V. Bonac.* Conurbation in Grossbritannien: *A. Kuhn.* Probleme der Baupreisstatistik und Baupreisindexberechnung: *P. Deneffe.*

HOLLAND—

Statistica—

Vol. 7, No. 1—Sequente analyse bij keurig van goederen: *J. M. Storch.* Dupliceerbaarheid en reproduceerbaarheid van waarnemingen: *J. A. van der Heiden.* Het matchen in de psychologie: *J. C. Spitz.* Tables for use in rank correlation: *L. Kaarsemaker.*

Vol. 7, No. 2—Overzicht van de ontwinkkeling der visserijtheorie: *J. Westenberg.* Omzetting van een in gehele graden Fahrenheit gegeven frequentieverdeling in een, welke, een klassebreedte van een graad Celsius heeft: *B. Heyna.* Het examen Statistisch Analyst 1952/53.

ITALY—

Giornale degli Economisti e Annali di Economia—

September–October 1953—La fecondità matrimoniale in Italia dal 1930 al 1950: *L. Lenti.* La ricerca delle leggi economiche mediante l'interpolazione dei dati statistici: *G. Sensini.*

INTERNATIONAL—

International Labour Review—

February 1954—Salaried employees in modern society: *F. Croner.* The international classification of occupations for migration and employment placement: *H. S. Carpenter.* Some aspects of Irish emigration: *J. Meenan.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part I, 1954, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Board of Trade.* Censuses of production for 1950, 1949 and 1948: summary tables Part I ... London, H.M.S.O., 1953. [ii], 41p. 11¼″. 2*s*.

Central Office of Information. Britain: an official handbook. London, H.M.S.O., 1953. vii, 334p. 9½″. 10*s*.

Colonial Office. The national income of Nigeria 1950–51; by A. R. Prest and I. G. Stewart ... London, H.M.S.O., 1953. viii, 123p. maps. 9½″. 8*s*. 6*d*. (Colonial Research Studies 11.)

Home Office. Statistics of foreigners entering and leaving the United Kingdom, 1939–1951 ... London, H.M.S.O., 1953. 37p. 9½″. 1*s*. 6*d*. Cmd. 8967.

General Register Office. Census 1951 England and Wales: County report ... London, 1953. 1, 90p. 22*s*. 6*d*. Essex. xlviii, 117p. 25*s*. Middlesex. xlvi, 69p. 20*s*. Surrey. xlvii, 78p. 21*s*. London, H.M.S.O., 1954. 13″.

General practitioners' records: an analysis of the clinical records of eight practices during the period April, 1951, to March, 1952; by W. P. D. Logan ... with a foreword by Sir John Charles ... London, H.M.S.O., 1953. viii, 131p. 9½″. 8*s*. 6*d*. (Studies on Medical and Population Subjects, 7.)

The Registrar-General's statistical review of England and Wales for the year 1949: supplement on general morbidity, cancer and mental health. London, H.M.S.O., 1953. ix, 186p. 9½″. 7*s*. 6*d*.

Interdepartmental Committee of Social and Economic Research. Guides to official sources: No. 3, Local government statistics. London, H.M.S.O., 1953. v, 34p. 9½″. 1*s*. 6*d*.

Medical Research Council. Vitamin C requirements of human adults: a report by the vitamin C subcommittee of the Accessory Food Factors Committee ... compiled by W. Bartley, H. A. Krebs and J. R. P. O'Brien. London, H.M.S.O., 1953. viii, 179p. plates. 9½″. 17*s*. 6*d*. (Special Report Series 280.)

Ministry of Fuel and Power. Report of the committee of enquiry into economy in the construction of power stations. London, H.M.S.O., 1953. iv, 19p. 9½″. 2*s*.

Ministry of Health. The causes of blindness in England; by Arnold Sorsby. London, H.M.S.O., 1953. iv, 41p. 9½″. 2*s*.

Ministry of Housing and Local Government. The cost of house maintenance: report by the committee of inquiry. London, H.M.S.O., 1953. 23p. 9½″. 9*d*.

Ministry of Labour and National Service. National Advisory Committee on the employment of older men and women: first report ... London, H.M.S.O., 1953. 62p. 9½″. 2*s*. Cmd. 8963.

Monopolies and Restrictive Practices Commission. Report on the supply of imported timber ... London, H.M.S.O., 1953. iv, 138p. 9½″. 4*s*. 6*d*.

Parliament. New Towns Act, 1946. Reports of the development corporations for the period ended 31st March, 1953: Aycliffe, Basildon, Bracknell, Crawley, Cwmbran, Harlow, Hemel Hempstead, Peterlee, Stevenage, Welwyn Garden City, Hatfield ... London, H.M.S.O., 1953. xix, 449p. illus. 9½″. 15*s*.

Royal Commission on the Taxation of Profits and Income. Minutes of evidence taken before the Royal Commission ... first to sixteenth day, 1951–1952. London, H.M.S.O., 1952. 455p. 13″.

First report ... February, 1953. London, H.M.S.O., 1953. vii, 20p. 9½″. 1*s*. Cmd. 8761.

Scotland. Department of Agriculture. Scottish agricultural economics: some studies of current economic conditions in Scottish farming. Volume IV. Edinburgh, H.M.S.O., 1953. 64p. 9½″. 2*s*.

Scotland. General Registry Office. Census 1951: report on the fifteenth census of Scotland ... Vol. I.—Part 10. County of Berwick. 32p. 7*s*. 6*d*. Part 12. County of Caithness. 30p. 7*s*. Part 13. County of Clackmannan. 32p. 7*s*. 6*d*. Part 14. County of Dumfries. 45p. 11*s*. Part 15. County of Dumbarton. 47p. 11*s*. 6*d*. Part 16. County of East

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Lothian. 37p. 8*s*. 6*d*. Part 17. County of Fife. 64p. 16*s*. 6*d*. Part 18. County of Inverness. 42p. 10*s*. Edinburgh, H.M.S.O., 1953–1954. 13″.

Treasury. Revenue and expenditure (England and Wales and Scotland) 1952–53 ... London, H.M.S.O., 1954. 16p. 9½″. 6*d*. Cmd. 9051.

Australia. *Commonwealth Bureau of Census and Statistics*. Census of the Commonwealth of Australia, 30th June, 1947. Part XXVII. Dwellings. p.1947–2102. 2*s*. 6*d*. Part XXVIII. Families. p.2104–2174p. 2*s*. 6*d*. Canberra, 1953. 13″.

Canada. *Dominion Bureau of Statistics*. Ninth census of Canada, 1951. Vol. I: Population, general characteristics. Vol. II: Population, cross classification of characteristics. Vol. IV: Labour force, occupations and industries. Vol. V: Labour force, earnings and employment of wage-owners. Vol. VI: Agriculture: Part II. Ontario, Manitoba, Saskatchewan, Alberta, British Columbia. Ottawa, 1953. 5 vols. 11″. $3 each vol.

Copenhagen. *Statistical Office*. Beboelses-og huslejeforhold i København, Frederiksberg og Gentofte samt hovedstadens omegnskommuner. Housing conditions and rents in Copenhagen, Frederiksberg and Gentofte and the suburbs of the capital, 1950. København, Bianco Lunos, 1953. 123p. maps. 11¼″. (Tabelvaerk Til Københavns Statistik 28.)

Cyrpus. *Statistics Section*. Some notes on the Cyprus economy; by Lefkos P. Georgiades. [Nicosia], 1953. Various paging. 13″.

Denmark. *Statistiske Department*. De Nordiske statistikmøder, København, juni, 1952. The Nordic statistics conferences, Copenhagen, June, 1952. København, 1954. 217, [iv]p. 9¼″. *kr*. 3.50. (Statistiske Meddelelser 4. 152.2.)

Egypt. *Ministry of Finance and Economy. Statistical Department*. Census of industrial production 1950. Cairo, 1953. viii, 123p. 12″.

Food and Agriculture Organization. Grain exports by source and destination. July, 1952–June, 1953. Rome, 1953. 20p. 11″. 1*s*. 3*d*.

Second world food survey. Rome, 1952. iii, 59p. 11″. 2*s*. 6*d*.

The state pf food and agriculture; review and outlook 1952. Rome, 1952 (London, H.M.S.O.). iv, 126p. maps. 11″. 5*s*.

France. *Institut National de la Statistique et des Études Économique*. La Pologne. Paris, Presses Universitaires de France, 1954. viii, 263p. maps. 9½″. (Mémentos Économique Série, M.8, 1953.)

Résultats statistiques du recensement général de la population effectué le 10 mars 1946. Vol. III. Population active, première partie, ensemble de la population active. Vol. IV. Familles. Paris, Presses Universitaires de France, 1952–53. 2 vols. 10½″.

Germany. *Statistisches Bundesamt*. Struktur der land-und forswirtschaftlichen Betriebe: Heft I. Bodennutzungssysteme Ergebnisse der Landwirtschaftlichen Betriebszählung vom 22 Mai, 1949. 336p. (Statistik der Bundesrepublik Deutschland 27.) Einführung in die methodischen und systematischen Grundlagen der Arbeitsstättenzählung vom 13.9.1950. 103p. (S.B.D. 44.) Die nichtlandwirtschaftlichen Arbeitsstätten in den Ländern und deren Verwaltungsbezirken nach der Zählung vom 13.9.1950. Heft 1. Schleswig-Holstein, Hamburg, Bremen. Heft 2. Niedersachen. Heft 3. Nordrhein-Westfalen. Heft 4. Hessen, Rheinland-Pfalz. Heft 5. Bayern. Heft 6. Baden-Wurttemberg. Heft 7. West-Berlin. 7 vols. (S.B.D. 46.) Die Abschlüsse der Aktiengesellschaften für das verlangerte Geschaftsjahr 1948–49. 60p. (S.B.D. 80.) Stuttgart-Köln, W. Kohlhâmmer, 1953–54. 11¾″.

Iceland. *Hagstofu Íslands*. Idnadarskýrslur árid 1950. Industrial production statistics 1950. Reykjavik, 1953. 87p. 9¾″. kr. 17. (Hagskýrslur islands II, 7.)

International Monetary Fund. The revival of monetary policy: texts and charts of an informal discussion at the eighth annual meeting of the Board of Governors ... September 11, 1953 ... Washington, International Monetary Fund, 1953. [vi], 16p. 11″.

Italy. *Istituto Centrale di Statistica*. Elezioni della camera dei deputati e del senato della repubblica 7 giugno 1953, dati riassuntivi. Roma, Istituto Poligrafico dello Stato, 1954. 46p. 10″. 300 L.

Isti uto Nazionale della Previdenza Sociale. Notizie statistiche 1948–1951. Roma, Istituto Poligrafico dello Stato, 1953. xxvii, 432p. 10½″.

Statistische delle pensioni dell' assicurazione obbligatoria invalidità vecchiaia e superstiti all' entrata in vigore della legge 4 aprile 1952, n. 218. Roma, 1953. 470,l p. 12¼″.

National Institute for Insurance Against Accidents at Work. Actuarial Statistical Service. Statistical information 1949. Rome, 1952. xiv, 219p. 12¼″.

Kenya. Report on the census on the non-native population of Kenya Colony and Protectorate taken on the night of the 25th February, 1948. Nairobi, 1953. viii, 133p. 12¾″.

Mauritius. *Central Statistical Office*. Census 1952 of Mauritius and of its dependencies: Parts I–III. Port Louis, Mauritius, 1953. 3 vols. 13″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Moçambique. *Repartição Tecnica de Estatistica.* Recenseamento da população civilizada em 21 de setembro de 1950. Lourenço Marques, 1953. xxxvi, 682p. 10½″.

New Zealand. *Census and Statistics Department.* Population census 1951: New Zealand life tables 1950–52. Expectations of life, chances of living and dying at each age; Maori lives. Wellington, 1953. 12p. 11″.

Population census, 1951. Vol. II. Ages and marital status. 84p. Vol. III. Religious professions (including summaries for dependent children, race, and war service). 28p. Wellington, 1953. 12¼″.

Norway. *Statistisk Sentralbyra.* Folketellingen 1. Desember 1950, første hefte: Folkemengde og areal i de ymse administrative inndelinger av landet hussamlinger i herredene. Oslo, 1953 [vi], 234p. 9½″. *kr.* 4. (Norges Offisielle Statistikk XI. 145.)

Det norske skattesystems virkninger på den personlige inntektsfordeling. The effects of the Norwegian tax systems on the personal income distribution. Oslo, 1954. 103p. 9½″. *kr.* 3. (Samfunnsøkonomiske Studier I.)

Organization for European Economic Co-operation. A standardized system of national accounts. Paris, 1952. 99p. 9½″.

Portugal. *Instituto Nacional de Estatistica.* IX recenseamento geral da população no continente e ilhas adjacentes em 15 de Dezembro de 1950. Tomo III. Vol. I. Condições perante o trabalho, encargos de familia e meio de vida. Tomo III. Vol. II. População agricola. Lisboa, 1953. 2 vols. maps. 10¼″.

Inquérito às explorações agrícolas do continente 1952: I. Provincias do Ribatejo, Alto Alentejo, Baixo Alentejo e Algarve. Lisboa [1953]. xiv, [iv], 317p. map. 10¼″. 40$.

Switzerland. *Eidgenössisches Statistisches Amt.* Arealstatistik der Schweiz 1952. Bern, 1953. 110p. maps. 11¾″. (Statistische Quellenwerke der Schweiz. Heft 246 Reihe C. 3.)

Eidgenössische Volkszählung i Dezember 1950: Band 22 Kanton Zürich. Bern, 1953. 296p. 12¾″. (S.Q. der S. Heft 247 Reihe Ae 22.)

Tanganyika. Report on the census of the non-native population taken on the night of 25th February, 1948. Dar Es Salaam, 1953. [iv], 73p. 13″. 25*s.*

United Nations. *Department of Social Affairs. Population Division.* Additional information on the population of Tanganyika (supplement to "The population of Tanganyika"). New York, 1953. vi, 32p. 10¾″. 2*s.* (Reports on the Population of Trust Territories no. 2, supplement.)

International research on migration. New York, 1953. vi, 33p. 10¾″. 2*s.*

The population of Ruanda—Urundi. New York, 1953. (London, H.M.S.O.) [vi], 37p. 11″. 3*s.* (Population Studies, 15.)

Economic and Social Council. Competition between steel and aluminium; prepared by the Industry Division, Economic Commission for Europe. Geneva, 1954 (London, H.M.S.O.). iii, 156p. 11″. 9*s.*

The European steel market in 1953; prepared by the Industry Division., Economic Commission for Europe. Geneva, 1954 (London, H.M.S.O.). ii, 100p. 11″. 5*s.*

Some important developments during 1953 in iron and steel technology; prepared by the Industry Division, Economic Commission for Europe. Geneva, 1954 (London, H.M.S.O.). [ii], 35 [2]p. 11″. 1*s.* 9*d.*

United States of America. *National Bureau of Standards.* Tables of 10^x (Antilogarithms to the base 10.) Washington, Supt. of Documents, 1953. viii, 543p. 10¼″. $3.50. (Applied Mathematics Series, 27.)

Table of natural logarithms for arguments between zero and five to sixteen decimal places. Washington, Supt. of Documents, 1953. x, 501p. 10¼″. $3.25. (Applied Mathematics Series, 31.) A reissue of Mathematical Table 10.

Uganda Protectorate. Report on the census of the non-native population of Uganda Protectorate taken on the night of the 25th February, 1948. [Entebbe], 1953. [ix], 136p. 9¾″. 21*s.*

II.—AUTHORS AND MISCELLANEOUS

Abbey (Helen). An examination of the Reed-Frost theory of epidemics. Baltimore, Md. Johns Hopkins Univ. School of Hygiene. [1953.] p.201–233. 9½″. (*Dept. Pap.* **285.**)

Ackoff (Russell L.). The design of social research. Chicago Univ. Press, 1953. (London, Cambridge Univ. Press). xi, 420p. 9½″. 56*s.* 6*d.*

Adler (Max K.). A note on forecasting demand for special offers in a magazine. *J. Industr. Econ.* (1953), **2**, 44–50. 8½″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Antosiewicz (H. A.) & Hammersley (J. M.). The convergence of numerical iteration. *Amer. Math. Mon.* (1953), **60**, 604–607. 10″.

Baltzell (E. Digby). Social mobility and fertility within an elite group. *Milbank. mem. fd. Quart.* (1953), **31**, 411–420. 9″.

Bartlett (M. S.). Approximate confidence intervals. *Biometrika* (1953), **40**, 12–19. 10¾″.

Approximate confidence intervals: II. More than one unknown parameter. *Biometrika* (1953), **40**, 306–317. 10¾″.

Beach (Sydney A.). The frequency of taste-blindness in Welsh populations. *Heredity* (1953), **7**, 401–407. 9¾″.

Berkson (Joseph). A statistical precise and relatively simple method of estimating the bio-assay with quantal response, based on the logistic function. *J. Amer. Statist. Ass.* (1953), **48**, 565–599. 9½″.

Bickley (W. G.). Bessel functions and formulae; compiled by W. G. Bickley, extracted from *British Association Mathematical Tables, Vol. X. Bessel functions, Part II, Functions of positive integer order.* C.U.P., for the Royal Society, 1953. p.xxx–xl. 11″. 3*s.* 6*d.*

Blade (J. C.) & Cuthbertson (J. W.). The structure and mechanical properties of copper-manganese-tin alloys. *J. Inst. Met.* (1953), **82**, 17–24. 11″.

Bliss (C. I.) & Beard (R. L.). Static and dynamic variation in the response of an insect to sublethal doses of two cases. *Bull. Conn. Agric. Exp. Sta.* (1953), **577**, 24p. 9″.

Bross (Irwin J.). Design for decision. New York, Macmillan, 1953. viii, 276p. 8¼″. $4.25.

Sequential medical plans. *Biometrics* (1952), **8**, 186–205. 9¼″.

Bross (Irwin J.) & Delaney (Marie M.). Significance tests for certain 2 × 2 tables. *Amer. J. Hyg.* (1952), **55**, 357–362. 9½″.

Burns (Arthur F.). The frontiers of economic knowledge; essays by Arthur F. Burns. Princeton University Press, 1954. xi, 367p. 9″. $5. (N.B.E.R. Gen. Ser. 57.)

Cambridge University. Department of Applied Economics. Regional variations in United Kingdom incomes from employment, 1948; by Phyllis Deane. *J. R. Statist. Soc.* A (1953). **116**, 123–139. 9¾″. (Repr. Ser. 75.)

The real product of the United Kingdom, 1946–52; by A. A. Adams. *Bull. Lond. Camb. Econ. Service* (1953), **6**, published in *Times Rev. Ind.* Sept. 1953. 6p. 9½″. (Repr. Ser. 76.)

Electronic computation in economic statistics; by J. A. C. Brown, H. S. Houthakker, and S. J. Prais. *J. Amer. Statist. Assoc.* (1953), **48**, 414–428. 9″. (Repr. Ser. 78.)

Carnap (Rudolf). The continuum of inductive methods. Chicago Univ. Press, 1952. v, 92p. 9″. $3.50.

Cavé (R.). Le controle statistique des fabrications. Paris, Editions Eyrolles, 1953. 431p. 9½″.

Cochran (William G.). An appraisal of the repeated population censuses in the Eastern Health District, Baltimore. New York, Milbank Mem. Fd. *Research in Public Health*, 1951 (1952). p.255–265. 9″.

The χ^2-test of goodness of fit. *Ann. Math. Statist.* (1952), **23**, 315–345. 10″.

Cox (D. R.) & Smith (W. L.). The superposition of several strictly periodic sequences of events. *Biometrika.* (1953), **40**, 1–11. 10¾″.

Cox (P. R.). Reproductivity in Great Britain: a new standard of assessment. *J. Inst. Actu.* (1953), **79**, 239–273. 8¾″.

David (F. N.) & Kendall (M. G.). Tables of symmetric functions. Part IV. *Biometrika* (1953), **40**, 427–440 + [6]. 10¾″. 4*s.* (New Statistical Tables XVIII.)

Davis (B. J.). Inflation: its treatment in accounts. London, Gee, 1953. 78p. 8½″.

De Paula (F. Clive). The control of service department costs. *Midland Regional Conf. Inst. Cost and Works Accountants* (1953). 6p. 11″.

Durham University. Durham Colleges. Dept. of Social Studies. Newspaper reading by university students: a survey carried out by S. Moos, A. Laing, A. J. Odber ... Dr. P. A. Bromhead. Durham, 1954. 55p. 9″. 2*s.* 6*d.*

Eisenklam (P.). Statistical methods in engineering experimentation. Parts I and II. *Research* (1953), **6**, 195–201, 231–237. 10″.

Evans (D. A.). Experimental evidence concerning contagious distributions in ecology. *Biometrika* (1953), **40**, 186–211. 10¾″.

Finney (D. J.). The estimation of the ED50 for a logistic response curve. *Sankhyā* (1952), **12**, 121–136. 11¼″.

Freeman (G. H.). Spread of disease in a rectangular plantation with vacancies. *Biometrika* (1953), **40**, 287–296. 10¾″.

Gilbert (Milton) & Kravis (Irving B.). An international comparison of national products and their purchasing power: a study of the United States, the United Kingdom, France, Germany and Italy. Paris, O.E.E.C., 1954. (London, H.M.S.O.). 203p. 2 fol. tabs. 9½″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Gokhale Institute of Politics and Economics. Survey of fertility and mortality in Poona District; by V. M. Dandekar, Kummudini Dandekar. [Poona], 1953. [ii], xii, 191p. 9¾″. 7*s.* 6*d.* (Publication, 27.)

Good (I. J.). The population frequencies of species and the estimation of population parameters. *Biometrika* (1953), **40**, 237–264. 10¾″.

Gray (J. G.). Management accounting. [London, Short Bros. & Marland Ltd.], 1953. 11p. 10½″.

Grundy (P. M.). The fitting of grouped truncated and grouped censored normal distributions. *Biometrika* (1952), **39**, 252–259. 10¾″.

Hammersley (J. M.). Capture-recapture analysis. *Biometrika* (1953), **40**, 265–278. 10¾″.

A non-harmonic Fourier series. *Act. Math. Stockh.* (1953), **89**, 243–260. 12″.

On counters with random dead time. *Proc. Camb. Phil. Soc.* (1953), **49**, 623–637. 10¼″.

Harrod (Roy). The dollar. London, Macmillan, 1953. vii, 156p. 7½″. 9*s.* 6*d.* Sir George Watson Lecture, 1954.

Harvey (W. A.). The maintenance of working capital. *Midland Regional Conf. Inst. Cost Works Accountants* (1953). 6p. 11″.

Hazelett (C. William). Practical answers to inflation, unemployment, taxation, and political leadership. Greenwich, Conn. Incentivist Publications, 1952. ix, [ii], 243p. 7″. 50*c.*

Hedrich (Arthur W.). Recent trends in meningococcal disease. *Publ. Hlth. Rep. Wash.* (1952), **67**, 411–420. 8½″.

Hill (A. Bradford). Observation and experiment. *New Engl. J. Med.* (1953), **248**, 19p. 9″.

Hodnett (G. E.). A uniformity trial on groundnuts. *J. Agric. Sci.* (1953), **43**, 323–328. 10¼″.

Hooker (P. F.) & Longley-Cook (L. H.). Life and other contingencies ... Vol. I. Cambridge, for the Institute of Actuaries and the Faculty of Actuaries, at the University Press, 1953. viii, 312p. 8½″. 22*s.* 6*d.*

Hultgren (Thor). Transport and the state of trade in Britain ... New York, N.B.E.R., 1953. xii, 114p. 9″. $1.50. (Occ. Pap. 40.)

International Economic Association. International economic papers No. 3. Translations prepared for the International Economic Association; ed. by Alan T. Peacock, Ralph Turvey, Elizabeth Henderson. London, Macmillan, 1953. 255p. 10″. 15*s.*

Irwin (J. O.). Contribution to a discussion on crop prediction. *Bull. Inst. statist. Inst.* (1954), **33**, 289–294. 9¾″.

Flavour assessment: a biometrician's viewpoint. *Chem. and Ind.* (1953), 1348–1352. 11″.

Johnston (B. F.). Japanese food management in world war II; by B. F. Johnston with Mosaburo Hosada and Yoshio Kusumi. Stanford, Calif. Univ. Press, 1953. (London, Geoffrey Cumberlege). xii, [ii], 283p. 9″. $7.50. (Food Agriculture and World War II.)

Kendall (D. G.). The effect of radiation damping and Doppler broadening on the atomic absorption coefficient. *Z. Astrophs.* (1938), **16**, 308–317. 9″.

A form of wave propagation association with the equation of heat conduction. *Proc. Camb. phil. Soc.* (1948), **44**, 591–594. 10″.

On the generalized "birth and death" process. *Ann. math. Statist.* (1948), **19**, 15p. 10″.

On the role of variable generation time in the development of a stochastic birth process. *Biometrika* (1948), **35**, 316–330. 10½″.

Les processus stochastiques de croissance en biologie. *Ann. Inst. Poincaré* (1952), **13**, 43–108. 10¾″.

Stochastic processes and the growth of bacterial colonies. *Symp. Soc. exp. Biol.* (1953), **7**, *Evolution*. 55–65. 9¾″.

Stochastic processes occurring in the theory of queues and their analysis by the method of the inbedded Markov chain. *Ann. math. Statist.* (1953), **24**, 338–354. 10″.

Kendall (D. G.) & Rankin (R. A.). On the number of Abelian groups of a given order. *Quart. J. math.* (*Oxford Series*) (1947), **18**, 197–208. 9¼″.

Kendall (M. G.). Exercises in theoretical statistics, with answers and hints on solutions. London, Griffen, 1954. vii, 179p. 8¼″.

Kiser (Clyde V.). Exploration of possibilities for new studies of factors affecting size of family. *Milbank mem. fd. Quart.* (1953), **31**, 436–480. 9″

Konijn (H. S.). Enige opmerkingen over Fisher's indexcijfers voor prijzen en hoeveelheden. *Statist. econmet. Onderzoekingen* (1953), **1**, 20–26. 11¾″.

Koop (J. C.). Preliminary report on the labour force sample survey of Rangoon. *Burma lab. Gazt.* (19), **6**, 5p. 13½″.

Latscha (R.). *Computer.* Tests of significance in 2 × 2 contingency table: extension of Finney's table. *Biometrika* (1953), **40**, 74–75, 12. 10¾″. 2*s.* 6*d.* (New Statistical Table XVIII.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Ledermann (W.) & Reuter (G. E. H.). Spectral theory for the differential equations of simple birth and death processes. *Phil. Trans. Series A* (1954), **246**, 321–369. 12″.

Leech (F. B.) & Bailey (G. L.). The effect on the health of lactating cows of treatment with galactopolpoietic doses of thyroxine or iodinated casein. *J. agric. Sci.* (1953), **43**, 236–251. 10¼″.

Leech (F. B.) & Grundy (P. M.). A nomogram for assays in randomized blocks. *Brit. J. Pharmacol.* (1953), **8**, 281–285. 9¾″.

Legendre (Adrien Marie). Tables of the complete and incomplete elliptic integrals. Reissued from Tome II of Legendre's *Traité des fonctions elliptiques*, Paris 1825: with an introduction by Karl Pearson ... London, The Biometrika Office, 1934. xlviii, 94p. 10¼″.

Lindley (D. V.). Estimation of a functional relationship. *Biometrika* (1953), **40**, 47–49. 10¾″.

Littell (Arthur S.). Estimation of the *T*-year survival rate from follow-up studies over a limited period of time. *Hum. Biol.* (1952), **24**, 87–116. 9½″.

University of Liverpool. *Department of Social Sciences.* Social aspects of a town development plan: a study of the County Borough of Dudley. Liverpool, Univ. Press, 1951. 168p. 8½″.

London School of Economics. Division of Research Techniques. The analysis of economic time-series. Part I: Prices: by M. G. Kendall. *J. R. Statist. Soc.* A (1953), **116**, 11–34. 9¾″. (Repr. Ser. 20.)

On the stochastic matrices associated with certain queueing processes; by F. G. Foster. *Ann. Math. Statist.* (1953), **24**, 355–360. 10¼″. (Repr. Ser. 22.)

Statistics and personnel management; by M. G. Kendall. *Nat. Conf. Inst. Personnel Management.* (1953). 16p. 8½″. (Repr. Ser. 23.)

MacNalty (Sir Arthur Salusbury), *editor.* The civilian health and medical services: edited by Sir Arthur Salusbury MacNalty ... Vol. I. The Ministry of Health Services; other civilian health and medical services. London, H.M.S.O., 1953. xi, 441p. 9½″. 45*s*. (Hist. of the 2nd World War. U.K. Medical Series.)

Matthews (R. C. O.). A study in trade-cycle history: economic fluctuations in Great Britain, 1833–1842. C.U.P., 1954. xiv, 228p. 9¼″. 25*s*.

National Institute of Economic and Social Research. The finance of public companies: an exploratory study of two industries. *Accounting Res.* (1953), **4**, 27p. 10″. (Repr. Ser. 1.)

Neisser (Hans) & Modigliani (Franco). National income and international trade: a quantitative analysis. Urbana, Univ. of Illinois Press, 1953. xviii, 369p. 10″. $7.50.

Netherlands. Central Planbureau. The consequences of the introduction of unemployment insurance; by G. van Duijn. The Hague, Central Planning Bureau, 1952. 32p. 9½″. (Monograph, 1.)

The analysis of unemployment figures and the alleged correspondence between causes and cures; by Jan Tinbergen. *Metroeconomica* (1953), **5**, 43–49. 9½″. (Repr. Ser. 27.)

De economische betrekkingen tussen Europa en de verbinden overzeese gebieden; door Dr. F. Hartog. *Econ. Statist. Ber.* (1954), **39**, 12p. 9½″. (Repr. Ser. 28.)

North Carolina Univ. of. Institute of Statistics. On a heuristic method of test construction and its use in multivariate analysis; by S. N. Roy. *Ann. Math. Statist.* (1953), **24**, 220–238. 9¾″. (Repr. Ser. 38.)

The analysis of variation in a natural population of lady beetles: Frank M. Sturtevant, *jr.*, Lyle D. Calvin and Orlando Park. *Biometrics* (1953), **9**, 117–126. 9″. (Repr. Ser. 39.)

A method for evaluating the effectiveness of health education literature; B. G. Greenberg, Mary Ellen Harris, C. Francis McKinnen and Sidney S. Chipman. *Amer. J. Publ. Hlth.* (1953), **43**, 1147–1155. 9½″. (Repr. Ser. 40.)

Peacock (Alan T.), *editor.* Income redistribution and social policy: a set of studies edited by Alan T. Peacock ... London, Cape, 1954. 296p. 8¾″. 25*s*.

P.E.P. Agricultural machinery: a report on the organization and structure of the industry, its products and its market prospects at home and abroad. London, P.E.P., 1949. vi, 110p. 9¼″. (P.E.P. Engineering Rep. 1.)

Richardson (J. Henry). An introduction to the study of industrial relations. London, Allen & Unwin, 1954. 442p. 8½″. 30*s*.

Romig (Harry G.). 50–100 binomial tables. New York, Wiley, 1953 (London, Chapman & Hall). xxvii, 172p. tabls. 8½″. 32*s*.

Stone (Richard). The measurement of consumers' expenditure and behaviour in the United Kingdom, 1920–1938. Vol. I; by Richard Stone, assisted by D. A. Rowe and W. J. Corlett, Renée Hurstfield, Muriel Potter. C.U.P., 1954. xxxv, 448p. tabls. 12½″ × 10″. 105*s*. (Studies in the National Income and Expenditure of the United Kingdom.)

Tustin (Arnold). The mechanism of economic systems: an approach to the problem of economic stabilization from the point of view of control-system engineering. London, Heinemann, 1953. xi, 161p. 8½″. 25*s*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Uppsala University. Institute of Statistics. Uppsala symposium on psychological factor analysis, 17–19 March, 1953. Copenhagen, Ejnar Munksgaard, Stockholm, Almquist & Wiksell, 1953. 91p. 9″. 10 *Dan cr.* (Nordisk Psykologi's Monograph Ser. 3.)

Utting (J. E. G.). Social accounts of local authorities: an experiment in sampling methods. C.U.P., 1953. x, 89p. fol. tabls. diagrs. 9½″. 16*s.* (Nat. Inst. Econ. Soc. Res. Occ. Pap. xvi.)

Wilks (S. S.). Analisis estadistico elemental; S. S. Wilks, traduccion de Sixto Rios y Jose Royo. Madrid, Consejo Superior de Investigaciones Cientificas, Dept. de Estadistica, 1952. 327p. 9¾″.

Wold (Herman). A study in the analysis of stationary time series; by Herman Wold. 2nd ed. with an appendix by Peter Whittle. Stockholm, Almqvist & Wiksell, 1954. viii, 236p. 9¾″. 28 *Sw. Kr.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

BANK OF ENGLAND

Pursuant to the Act 7th and 8th Victoria, cap. 32 (1844)

(000's omitted)

1	2	3	4	5	6	7	8
Issue Department						Collateral Columns	
Liabilities	Dates (Wednesdays)	Assets					
Notes Issued		Govt. Debt £(11,015) and Govt. Securities	Other Securities	Gold Coin and Bullion*	Silver Coin†	Notes in Hands of Public	Minimum Discount Rate
£		£	£	£	£	£	
1,525,357	Jan. 7	1,521,767	721	357	2,512	1,502,034	4%
1,500,357	,, 14	1,496,765	721	357	2,514	1,472,952	
1,500,357	,, 21	1,496,733	752	357	2,515	1,454,987	
1,500,357	,, 28	1,496,759	730	357	2,511	1,448,904	
1,500,357	Feb. 4	1,496,780	705	357	2,515	1,451,630	
1,500,357	,, 11	1,496,773	713	357	2,514	1,456,701	
1,500,357	,, 18	1,496,758	727	357	2,515	1,459,052	
1,500,357	,, 25	1,496,781	707	357	2,512	1,464,747	
1,500,357	Mar. 4	1,496,758	730	357	2,512	1,474,670	
1,500,357	,, 11	1,496,727	762	357	2,511	1,481,015	
1,500,357	,, 18	1,496,770	716	357	2,514	1,481,826	
1,550,357	,, 25	1,546,774	716	357	2,510	1,488,754	
1,550,357	Apr. 1	1,546,695	791	357	2,514	1,508,965	
1,550,357	,, 8	1,546,771	716	357	2,513	1,517,326	
1,550,357	,, 15	1,546,773	715	357	2,512	1,516,902	
1,550,357	,, 22	1,546,754	734	357	2,512	1,511,079	
1,550,357	,, 29	1,546,789	707	357	2,514	1,514,019	
1,550,357	May 6	1,546,712	774	357	2,514	1,516,511	
1,550,357	,, 13	1,546,781	708	357	2,511	1,519,723	
1,550,357	,, 20	1,546,779	708	357	2,513	1,523,605	
1,550,357	,, 27	1,546,703	786	357	2,511	1,532,411	
1,600,357	June 3	1,596,787	701	357	2,512	1,543,647	
1,600,357	,, 10	1,596,777	708	357	2,515	1,542,621	
1,600,357	,, 17	1,596,779	708	357	2,513	1,539,102	
1,600,357	,, 24	1,596,701	784	357	2,515	1,540,231	
1,600,357	July 1	1,596,779	708	357	2,513	1,544,950	
1,600,357	,, 8	1,596,742	748	357	2,510	1,556,577	
1,600,357	,, 15	1,596,732	756	357	2,512	1,566,956	
1,600,357	,, 22	1,596,778	707	357	2,515	1,586,523	
1,625,357	,, 29	1,621,780	707	357	2,513	1,598,842	
1,625,357	Aug. 5	1,621,778	710	357	2,512	1,598,457	
1,625,357	,, 12	1,621,692	795	357	2,513	1,579,500	
1,625,357	,, 19	1,621,711	775	357	2,514	1,558,633	
1,575,357	,, 26	1,571,781	706	357	2,513	1,545,669	
1,575,357	Sept. 2	1,571,784	705	357	2,511	1,543,533	
1,575,357	,, 9	1,571,751	736	357	2,513	1,540,398	
1,575,357	,, 16	1,571,697	791	357	2,512	1,538,025	3½
1,575,357	,, 23	1,571,783	705	357	2,512	1,531,636	
1,575,357	,, 30	1,571,711	774	357	2,515	1,532,667	
1,575,357	Oct. 7	1,571,696	791	357	2,513	1,535,526	
1,575,357	,, 14	1,571,755	731	357	2,514	1,535,300	
1,575,357	,, 21	1,571,781	706	357	2,513	1,530,837	
1,575,357	,, 28	1,571,709	776	357	2,515	1,532,350	
1,575,357	Nov. 4	1,571,710	775	357	2,515	1,539,636	
1,575,357	,, 11	1,571,735	754	357	2,511	1,544,942	
1,575,357	,, 18	1,571,725	761	357	2,514	1,545,507	
1,575,357	,, 25	1,571,728	761	357	2,511	1,549,908	
1,625,357	Dec. 2	1,621,764	724	357	2,512	1,566,585	
1,625,357	,, 9	1,621,741	748	357	2,511	1,597,980	
1,675,357	,, 16	1,671,728	761	357	2,511	1,632,142	
1,675,357	,, 23	1,671,692	797	357	2,511	1,640,265	
1,675,357	,, 30	1,671,759	726	357	2,515	1,619,930	

* At 248*s.* 0*d.* per fine oz.

† Coin other than Gold Coin.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

WEEKLY RETURN

for Wednesday in each Week, during the year 1953

(000's omitted)

9	10	11	12	13	14	15	16	17	18
BANKING DEPARTMENT									
Liabilities				DATES (Wednesdays)	Assets				Totals of Liabilities and Assets
Capital (£14,553 and Rest	Public Deposits‡	Bankers' Deposits	Other Deposits		Govt. Securities	Discounts and Advances	Other Securities	Reserve (Notes and Coin)	
£	£	£	£		£	£	£	£	£
18,191	37,489	275,173	73,189	Jan. 7	358,690	6,105	14,512	24,735	404,042
18,226	45,104	273,388	69,287	,, 14	353,940	9,740	13,517	28,808	406,005
18,261	49,624	268,740	66,538	,, 21	327,530	14,852	13,971	46,810	403,163
18,300	43,632	274,534	66,143	,, 28	318,725	6,517	24,483	52,884	402,609
18,370	43,491	272,043	66,887	Feb. 4	309,105	10,154	31,393	50,139	400,791
18,408	58,347	279,074	69,037	,, 11	353,984	6,105	19,601	45,176	424,866
18,415	57,113	280,413	69,707	,, 18	353,604	11,145	18,010	42,889	425,648
18,448	54,406	292,647	68,803	,, 25	377,194	7,070	12,715	37,325	434,304
18,473	45,965	269,228	70,030	Mar. 4	356,764	4,343	15,181	27,408	403,696
18,491	46,321	281,941	70,831	,, 11	378,899	3,238	14,372	21,075	417,584
18,504	48,601	281,715	71,549	,, 18	377,984	7,060	15,079	20,246	420,369
18,533	46,665	288,310	74,989	,, 25	343,120	6,169	15,901	63,307	428,497
18,551	46,371	269,261	74,672	Apr. 1	342,389	9,668	13,610	43,187	408,855
17,717	50,796	280,330	74,145	,, 8	358,979	18,438	10,753	34,818	422,988
17,746	58,665	268,990	73,808	,, 15	357,899	13,471	12,583	35,256	419,209
17,770	50,573	273,463	72,723	,, 22	351,209	9,145	13,082	41,093	414,529
17,827	53,249	261,814	73,878	,, 29	329,279	13,815	25,501	38,173	406,768
17,861	53,877	268,993	65,330	May 6	321,509	13,171	35,715	35,656	406,061
17,862	60,454	363,447	67,217	,, 13	348,214	9,965	18,355	32,447	408,980
17,914	57,074	273,194	70,167	,, 20	365,109	6,640	17,946	28,654	418,349
18,974	61,435	260,315	70,960	,, 27	363,989	5,960	20,897	19,837	410,684
18,064	56,220	267,081	70,510	June 3	334,959	6,520	11,812	58,584	411,875
18,070	61,249	267,388	71,577	,, 10	335,629	8,881	14,149	59,625	418,284
18,086	60,828	268,348	73,494	,, 17	336,839	6,871	13,881	63,165	420,756
18,133	54,299	276,680	68,152	,, 24	333,084	8,095	13,838	62,246	417,264
18,157	60,880	281,641	69,474	July 1	333,284	16,150	22,897	57,821	430,152
18,221	50,757	266,646	66,658	,, 8	327,444	16,000	12,620	46,217	402,282
18,244	48,390	278,896	66,641	,, 15	350,779	12,980	12,552	35,859	412,171
18,247	48,311	272,525	66,657	,, 22	364,334	12,620	12,530	16,276	405,760
18,305	48,240	274,773	67,470	,, 29	343,924	10,725	25,158	28,981	408,788
18,366	58,229	262,152	67,821	Aug. 5	342,319	9,575	25,320	29,353	406,568
18,420	38,156	273,927	65,149	,, 12	316,914	7,290	23,126	48,321	395,652
18,432	44,811	269,673	65,759	,, 19	306,829	6,200	16,445	69,201	398,675
18,445	40,346	277,511	67,277	,, 26	351,529	3,640	16,251	32,159	403,579
18,474	41,182	278,705	67,981	Sept. 2	352,277	6,560	13,200	34,306	406,342
18,489	34,587	275,793	67,782	,, 9	337,702	8,015	13,489	37,445	396,651
18,494	31,070	285,512	67,804	,, 16	341,757	7,545	13,712	39,867	402,880
18,529	30,406	298,739	68,111	,, 23	351,647	4,280	13,611	46,247	415,785
18,553	30,569	287,278	70,556	,, 30	332,467	5,154	24,138	45,197	406,956
17,707	27,771	287,319	70,912	Oct. 7	337,837	9,309	14,232	42,331	403,709
17,744	33,904	284,805	68,806	,, 14	338,902	8,990	14,824	42,543	405,259
17,768	27,603	292,017	68,013	,, 21	333,962	9,575	14,867	46,997	405,401
17,817	27,496	287,331	68,926	,, 28	312,767	12,855	25,473	45,475	401,570
17,845	38,541	280,984	69,461	Nov. 4	326,286	10,935	31,430	38,180	406,831
17,862	19,824	286,725	74,725	,, 11	339,296	8,497	18,466	32,877	399,136
17,914	26,075	288,755	70,284	,, 18	341,487	10,097	19,150	32,294	403,028
17,946	21,848	288,751	69,907	,, 25	347,916	7,627	15,021	27,888	398,452
17,997	28,325	290,232	70,689	Dec. 2	324,827	7,662	13,563	61,191	407,243
18,000	21,520	287,142	68,178	,, 9	343,087	8,103	13,859	29,791	394,840
18,080	21,443	276,009	69,151	,, 16	316,246	8,728	14,086	45,623	384,683
18,125	22,929	273,174	71,968	,, 23	329,087	5,248	14,372	37,489	386,196
18,150	22,156	290,177	70,375	,, 30	316,606	4,913	21,511	57,828	400,858

‡ Including Exchequer, Savings Banks, Commissioners of Nat. Debt., and Div. Accounts and H.M. Treasury Special Account.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

VOL. 117.] [PART III

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART III, 1954.

World Supply and Requirements of Farm Products

By Colin Clark

[Read before the Royal Statistical Society, March 24th, 1954,
Professor A. Bradford Hill, C.B.E., F.R.S., Ex-President, in the Chair]

Just over twenty-five years have elapsed since the auspicious occasions when the writer of the present paper received the Frances Wood Prize, and was admitted to the Society, to the accompaniment of the genial handshake of A. W. Flux (later Sir Alfred Flux). Quarrel though some of us might with the leisurely procedure of the Statistical Department of the Board of Trade, as it was in those days, we all recognized in Flux one of the most delightful personalities, and acute and critical intelligences, which have ever adorned this Society.

These facts, however, are not of statistical importance. While the present writer falls far short, in wisdom and longevity, of the great figures of our Society, he nevertheless makes the claim that he has now had sufficient duration of membership to entitle him to a few paragraphs of general reflexions, before he gets down to business.

It is a very valuable exercise to sit down before a shelf containing the complete *Proceedings* of our Society and to look through each of the earlier volumes in turn, and read as many as one can of the important papers, and the discussions which followed them. What a variety of subjects they discussed—nothing came amiss to them, and all the leading figures of the Society seemed to join in the discussion, with contributions very much to the point. And it will be so much the worse for us if we look back on them with the supercilious idea that they were a lot of amateurs, in comparison with the highly specialized statisticians of to-day, and their intellectual feats. The verdict of history may be that they contributed a great deal more to the welfare of mankind than we are ever likely to do.

It is true that the extraordinarily increased complexity of modern knowledge makes a very strong case for specialization. Our brethren of the medical profession had to face a similar issue, a generation or more before we did. While they now promote the study and practice of many highly specialized branches of medicine, they have nevertheless preserved the admirable rule (in the English-speaking countries—in some European countries the rules are laxer) that no man may practice any of these specialized branches of the subject unless he has first passed through a university course which gives him a basic understanding of every branch of medicine. The writer was once privileged to listen to a medical discussion concerning a conscientious specialist who sacrificed the greater part of his leisure hours in order to read every available book and periodical dealing with his specialism. A well-known general practitioner, who had also been in his time both a distinguished medical administrator and a teacher of medicine, commented that all these efforts might perhaps succeed in raising him from 95 per cent. to 99 per cent. efficiency as a specialist practitioner. We talk about the law of diminishing returns in some branches of economic activity ; but nowhere are its workings more apparent than in the field of specialized study.

The range and usefulness of statistical science have grown with such intoxicating rapidity during the last two decades that we are in real danger of losing cohesion and splitting up into

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

innumerable groups of recondite specialists, uninterested in each others' work, learned but ultimately sterile. It is the duty of all of us to help prevent this happening, though the biggest responsibility will probably lie upon those who teach. The writer has found that it is a point worth making to ambitious undergraduates that, the more the world becomes filled with specialists of every variety, the greater will be its need for men of sufficient knowledge and ability to give orders to them and to co-ordinate their work. For it is inherent in the nature of the specialist, that he must have someone who can give him orders, and make use of his results.

It has long been the complaint of the heads of statistical departments, both in business and in the Civil Service, that they can never really get on top of their work for the reason that their able young men, as fast as they train them, are grabbed for high executive posts elsewhere. And so much the better that they should be. A really good statistical training, not merely academic training but on the job, should give to a capable young man such knowledge of the world, breadth of vision, and skill in analysing a complex situation, as to make him a really admirable executive. But the training which can be expected to achieve these results, though it should contain a good deal of modern mathematics, should certainly not be confined to this subject. The world would be much better off if our learned brethren of the actuarial profession, who so often rise to high executive or advisory positions, had had a less narrow training. That some members of the actuarial profession are now taking an active part in the affairs of this Society is indeed a welcome sign that the old order is beginning to change. Is it asking too much to look forward to a time when no man can call himself a statistician unless he possesses at least some basic knowledge concerning all the fields of application of statistics—its use in physics, in biology and agriculture, in quality control and testing, in actuarial work, in psychology, in demography and in economics?

The field suggested for the present paper, though not involving the degree of versatility postulated above, nevertheless transcends several of the boundaries of statistical specialism, and calls for some proficiency in three different branches. It demands a review of agricultural and geographical statistics of the world's present agricultural production. It demands work in demographic statistics, to estimate the sizes of the populations which will grow up to consume this food in different parts of the world. And then it demands the analysis of the more purely economic statistics, of the influence which changing prices and incomes and other economic variables will have, on the one hand, upon the demand for food as compared with the demand for other commodities, and on the other hand, upon the amount of labour and other resources which will be available to farmers, who have to compete for them with other producers.

Our subject matter should include fish, which clearly substitutes for other foods, and in some countries is produced by the labours of men who spend some of the year fishing and some farming: an estimate for food produced by gardeners and other small scale producers, and also by nomadic herdsmen: and non-food farm products (tea, tobacco, rubber, wool, hides, cotton, linseed oil etc.). From an attempt to exclude all these from our study we should derive great labour and little good. Some of them are quite inevitable joint-products arising out of food production—such as hides, wool and tallow—and even where they are not, they are produced by the same land, labour and equipment as produces other farm products. Our wisest course, therefore, is to make our field that of all farm and fishery products, as defined above, and when we come to analyse demand, to include in our analysis requirements of textile fibres, industrial fats and oils, hides and skins, tobacco and rubber, as well as requirements of food as such.

Similar reasoning tells us that it is better to measure the economic value of our farm and fishery products purely as farm and fishery products, at farm or wharf, and to exclude from our review the industrial processes, transport, merchanting and storage to which they are subjected.

To measure real output (as opposed to money output) of the products of manufacture, of service industries, or of national product as a whole, it is always necessary to use some sort of index-number method in order to take account of the innumerable variety of minor products or services whose quantities cannot be directly enumerated. Farm and fishery products are much more manageable in this respect. If we are content to average out some differences in quality, and group together some minor products such as vegetables, we are in a position to make a complete inventory of output, or consumption, in physical terms. To compare output at different times, or in different countries, we can apply to these physical quantities, such relative prices, or weights, as we deem appropriate.

One thing is clear however—that it is desirable to apply an international scale of the relative

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

values of different commodities. Many countries, now, have their own scales of relative prices for different farm products, governmentally determined in response to all sorts of political and other considerations, and not necessarily bearing much relation either to relative costs of production, or to any other economic factors.

The present writer has worked in this field for many years using the device of an "International Unit". This device was first used, as a matter of fact, for making international comparisons of national incomes, in an article written for *Weltwirtschaftliches Archiv* in 1937. Probably without due thought, a new unit was created whose use was to persist for many years into the future, defining an International Unit as a *quantity of goods exchangeable for* $1 *in the U.S. over the average of the decade* 1925–1934. This decade was chosen, at the time, because it included five normal and five depression years. If we were re-defining a unit now, we should doubtless treat depression years as abnormal, and try to pick a base period of reasonably full employment. As a unit, the present one has many defects; but such a large mass of material referring to industry, agriculture, consumption and national incomes and products, has been accumulated already on this basis, that it is not possible to change it without extraordinary effort.

Until the Second World War, the old International Institute of Agriculture, located in Rome, in spite of its small staff and exiguous financial appropriation, used to produce a Yearbook which gave remarkably comprehensive and accurate figures of agricultural and grazing output in most countries, though unfortunately it had little to say on the net supply remaining for sale after seed and fodder requirements had been met. Seed requirements could be estimated without difficulty, but the very much larger utilization of grain for fodder was a statistical unknown. After the war, the International Institute of Agriculture was succeeded by the Food and Agriculture Organization, with enormously greater staff and funds—some say that the application of additional resources to this object has yielded diminishing returns. Be that as it may, F.A.O. set about compiling on an internationally comparable scale, for the first time, "Food Balance Sheets" in which the net available supplies, after deducting for seed, fodder and waste, were calculated. During the last few years F.A.O. has also succeeded in preparing a valid series of world index numbers of agricultural production, including non-food products, which again are based on net available supplies and not on gross products, as was the case with some previous attempts at index number construction.

In choosing their weights, F.A.O. decided to use the export price which each commodity commanded on the world market during the years 1934–8. By a fortunate coincidence, a metric ton of wheat, over the average of this period, sold for exactly 100 gold francs. This was taken as the basis, and all other commodities expressed in terms of their exchange ratio against wheat in world export markets. Where a world market figure did not exist, an exchange ratio against wheat was worked out in the most important market for which data were available. This system of weights was compiled with great thoroughness and ingenuity.

While the present writer's decision to continue to compile his data in the previous "International Units" (I.U.) was to a considerable extent due to his having such a large quantity of data accumulated in this form already, it is also permissible to point out that it is regrettable that F.A.O. should have picked a base period in which the prices of agricultural exports in the world market were quite so abnormally depressed. A particularly low relative value, for example, is thus given to rice, thereby greatly affecting the measure of output in the important regions of the world. A somewhat less distortion, but over a wider field, is found in the case of many livestock products, which commanded a more disadvantageous relative price in those years than in times before or since.

With production and consumption of agricultural products, as with national incomes as a whole, the I.U. or some such unit may be a reasonably satisfactory method of comparing two countries, or two times, where the levels of real income, and the commodities produced or consumed, do not differ in too extreme a manner. It may therefore be valid for comparing economically advanced countries. But when we come to the poorer communities of the world the I.U. or any similar unit, becomes progressively less satisfactory. This is because the whole scale of relative values alters.

Consider the scale of relative values in a wealthy (for so we appear to them) community in Western Europe or North America, and in an oriental country. Certain grains which we regard as comparatively low valued commodities to be fed to livestock, are to them much-sought-after articles of diet. Rice, however, produced under protected conditions in some western countries,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

or else having considerable transport charges to bear, is a relatively more costly article to us than to them. On the other hand, fruits and vegetables, which in the western world are often transported over long distances, by a complex and very costly merchanting system, for which we are

Price Weights per Metric Ton

Commodity	*F.A.O.* (*Gold Francs* 1934–8)	*I.U.* (*$ of* 1925–34)	*O.U.* (*Rupees of* 1948–9)
Grains			
Wheat	100	32·7	332
Rice, rough	70		
milled	108	69.0	462
Rye	80	24·1	300
Barley	70	23·2	252
Oats	70	28·1	335
Maize	60		
Millet	70	19·0	235
Buckwheat	60		
Sorghum	60		
Wheat offals		15·0	150
Starchy Roots			
Potatoes	50	33·1	300
Sweet potatoes	60		
Taro	60	40·5	450
Cassava, Manioc, Yuca	15		
Sugar[a]			
Refined	100		
Raw	93	58·0	640
Pulses and Oil Crops			
Dry beans, peas	100	57·5	291
Castor beans	180		
Cotton seed	60		
Copra	140	112	
Flax seed	140	78·1[d]	
Groundnuts unshelled	120	86[e]	430[e]
Hempseed	100		
Mustard-seed	130	88[e]	547[e]
Sesame	180	127[e]	750[e]
Soybeans	80		
Olive oil	800		
Palm kernels	110		
Poppy seed	160		
Rapeseed	140	88[e]	547[e]
Other oils and fats		200	1000
Nuts			
Unshelled	200	300	
Fruits			
Total	120		
Citrous	135	71·5	570
Deciduous	140		
Grapes	60		
Bananas	60		
Dates	225	34	100
Figs	75		
Berries	420		
Dried fruit	360		
Wine	150		
Vegetables	90	18·4	46
Livestock Products			
Beef	400		
Beef and veal	500	200	1550
Pork	700	304	2400
Mutton and lamb	600	271[e]	2750[e]
Buffalo meat	500		
Goat meat	600		
Horse meat	400		
Poultry	750	506	1500
Game and rabbit	750		
Offal	400	100	
Animal fats	400		
Milk	100	39·5	850
Skim milk	40		
Eggs	750	317	2700
Cheese		369	2600
Butter		800	5600
Fish		150	725
Fibres			
Abaca	250		
Cotton	800	290	2975
Flax fibre	900	182	
Hemp fibre	700	161	
Henequen	225		
Jute	200	132·5	580
Sisal	225		
Wool, greasy basis	1400	566	2125
Silk, raw	7500	576[f]	1900
Other Crops			
Cacao	300	211[b]	
Coffee	500	547	5500
Tea	1500	500	4690
Tobacco	1400	349	1730
Rubber	900	900	9000

([a]) i.e., value on farm of cane or beet, per ton of sugar content. ([b]) Cocoa beans. ([c]) Value of oil content only. ([d]) Value of oil content 51·6. ([e]) Includes goat meat. ([f]) Cocoons.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

willing to pay comparatively high prices, are purchased by the Oriental (if he has to purchase them at all, for he usually grows them for himself) in his local market, at extremely low prices. Milk is a commodity of which most western countries produce far more than they can drink, so that the surplus has to be converted into butter or cheese, with many of the valuable nutrients in the milk being fed to livestock in the form of buttermilk or whey. In most Oriental countries, however, the relatively small output of milk is greatly prized, and practically all reserved for human food, except for the minimum required for calf rearing, and exchanges at a much higher price, relative to other farm products, than western farmers' milk does.

These considerations have led the writer to introduce, for national income measurements on the one hand, and for measuring the production and consumption of farm products on the other, a new unit, to be used side by side with the I.U., described as the Oriental Unit, or O.U. Any other possible choice of base for such a unit would, it appears, have been statistically inferior to that which was in fact made, namely *the quantity of goods exchangeable for an Indian rupee in the year* 1948/9. For it is in respect of India, for this year, that we have the only comprehensive study so far available of the national product of a poor oriental community. (Japan is not far off counting as a western community for this purpose.)

Even so, we by no means have all the information that we wish. India's output of farm and fishery products in that year (in the hands of the producers before any distributive costs had been incurred) is estimated, apparently fairly carefully, at 40·9 billion rupees. Unfortunately the National Income Committee decided not to publish the detailed break-down of quantities and prices. Rationing and price control were in force in many regions of India during that year, and considerable quantities of farm products were sold at prices higher than the permitted official maximum. Furthermore, the existence of rationing and price control distorts the entire structure of supply, demand, and prices. The relative prices prevailing under these conditions cannot be used to provide suitable weights for international or inter-temporal comparisons.

It was necessary, therefore, to adopt the following rather roundabout device. Precise quantities of Indian output in 1948–49, less consumption for seed and fodder and waste, are available in the Food Balance Sheet submitted by the Indian Government to F.A.O. To these are applied the average prices per ton prevailing in 1931–32 as shown in Professor Rao's book, *The National Income of British India*. For livestock products (other than fish), and for fruit and vegetables, Professor Rao's data were revised and supplemented by more recent information, adjusted for the change in the general level of prices between 1931–32 and 1950–51.

The 1948–49 quantities, multiplied by the prices (actual or hypothetical) of 1931–32, gave a total of 8·15 billion rupees, or almost exactly one-fifth of the actual income recorded for 1948–49. The 1931–32 prices multiplied by 5 are therefore taken as standards for converting to O.U. figures of output, trade or consumption of farm products.

This method is not entirely satisfactory, but it does at any rate give an aggregate agricultural production which accords with the recorded Indian figure for 1948–49, and as we are choosing in any case an arbitrary base for our new series the use of 1931–32 figures multiplied by 5 will not do any serious harm.

It is probably the case, as Mr. Desai contended in a paper in this *Journal* (Part IV, 1948) that Professor Rao's price figures were too low. The factor of 5 which we have applied to them includes therefore an allowance for their original underestimation, as well as for the change in prices between 1931–32 and 1948–49. The procedure is crude and it is hoped that it will shortly be replaced by something more accurate.

We are now in a position to tabulate systematically the farm and fishery output of most of the world, measured on one of these international scales. For the main conclusions, the writer has used the quantities shown in the F.A.O. Food Balance Sheets for 1934–38 and for 1950–51, but has valued them in I.U.'s (or O.U.'s) and not on the F.A.O. scale of relative values. The difference brought about by this procedure is shown in the table; it is considerable in a number of countries.

There are several alternative sources of information, but it does not seem necessary now for us to take them into account. In the first and second editions of *The Conditions of Economic Progress* the writer prepared tables, referring generally to the period 1934–45, of the I.U. value of farm (not including fishery) output, using quantities as given by the International Institute of Agriculture, expressed in I.U. terms. The lack of data on fodder and seed requirements was

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1

World Agricultural Production in Millions of I.U.'s or O.U.'s

Definition of units:

I.U.—Quantity of goods purchasable by one U.S. dollar in 1925–34.
O.U.— „ „ „ „ Indian rupee in 1948–49.

	Prof. Moore Production Net after provision for Equipment, Fertilisers, etc.		*Production less Fodder-Seed and Waste,* 1934–38	*"Ratios" (see text)*		*Production from* 1934–38 *Figures carried forward by means of F.A.O. Index Numbers*				*Product Measured in Millions of O.U.'s*		*De Vries' Aggregate Agricultural Production, Million O.U.'s*	
	Crops and Livestock, 1931–35	*Fishing and Forestry,* 1931–35		*Pre-war*	1950–51	1948–49	1949–50	1950–51	1951–52	1934–38	1950–51	*Pre-war*	*Post-war*
Albania	21·9	5·7				193·3[k]	215·5[k]	208·6[k]	215·5[k]				
Algeria			1309·0[d]	1·09	1·25	1546·0	1405·8	1376·9	1420·0				
Argentine			993·0[e]	1·18	1·26	1107·6	1180·6	1116·9	1066·2				
Australia	190·9	35·3	244·5	1·16	0·95	156·1	181·4	215·1	197·2				
Austria	170·0	9·8	250·4[a]	1·13[a]	1·24[a]	260·3[a]	324·6[a]	320·5	311·5				
Belgium			2227·0[d]	1·70	1·37	2136·3	2296·4	2393·7	2414·7	20304	19286		
Brazil	236·4	10·2								3914		4120	3140
Bulgaria													
Burma			959·0	1·17	1·01	1290·6	1211·2	1343·6	1442·9				
Canada			178·6	1·48	1·42	194·4	200·5	216·2	219·1	1563	1923	1290	1670
Ceylon			119·9[d]	0·97	0·91	149·1	164·3	159·6	171·6	1025	1301		
Chile													
China			349·6[d]	1·75	1·60	487·8	554·6	548·1	571·5	3207	5066		
Colombia			295·8	1·57	1·60	430·8	460·3	466·0	530·8	2849	4667		
Cuba													
Czechoslovakia	359·0	62·5	398·3	1·40	1·24	391·0	477·0	513·1	499·6				
Denmark	248·1	18·2	512·0	1·20	1·09	432·9	444·5	445·5	429·9	4556	4123		
Egypt													
England and Wales	465·0	58·5											
Estonia	52·5	2·6											
Finland	110·9	61·0	162·0	1·32	1·15	155·2	176·7	176·7	185·5			1660	1560
Formosa													
France	1492·5	130·5	1843·0	0·97	0·94	1763·1	1817·9	2002·6	1985·2	4776		4950	4120
French Indo-China						165·0[k]	181·8[k]	184·3[k]	199·0[k]				
French Morocco													

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Germany	1882·0	207·1	3052·0(c)		1·17(j)	1244·8(j)(l)	1517·6(j)(l)	1715·5(j)(l)	1818·1(j)(l)				
Greece	172·9	4·0	236·2(e)	1·07	1·20	207·6	297·5	250·3	290·0				
Hungary	296·8	13·9											
India			6826·0(f)	1·25(f)	1·04	4164·7(l)	4316·3(l)	4240·5(l)	4240·5(l)	61999(f)	40173	42450	44000
Indonesia (Java and Madura)			1351·0(h)			448·3(k)	493·4(k)	493·4(k)	521·9(k)	11370		11400	11450
Ireland (Eire)	151·3	1·0	222·4	1·34	1·25	206·0	215·5	217·4	210·4				
Ireland (Northern)	35·2	3·8											
Italy	1357·1	89·7	1301·0	1·03	0·98	1234·2	1298·9	1388·7	1438·3				
Japan			2028·0	1·42	1·18	1513·9	1681·2	1927·2	1919·3	11644	9887		
Korea													
Latvia	92·3	5·9											
Lithuania	104·6	2·9											
Luxembourg	7·6	0·7	(b)	(b)		(b)	(b)	(b)	(b)				
Madagascar						78·8(k)	76·2(k)	76·2(k)	81·4(k)	1365		2080	3140
Malaya						249·5(k)	246·2(k)	256·4(k)	225·3(k)				
Manchuria													
Mexico						462·6(k)	503·4(k)	529·2(k)	536·7(k)				
Netherlands	222·1	11·1	488·9	1·47	1·31	517·4	592·6	599·4	608·0				
New Zealand			402·7(d)	1·23	1·25	441·2	453·5	473·6	449·3				
Norway	58·6	29·8	290·8	1·09	1·07	366·3	339·0	375·4	429·6				
Pakistan			(g)	(g)	1·26	1682·5(l)	1654·0(l)	1696·5(l)	1668·0(l)		14073	12000	12900
Peru			172·3(d)	1·23	1·26	173·0(k)	176·3(k)	183·9(k)	195·3(k)	1545			
Philippines			469·7	1·32	1·26	244·8(k)	270·8(k)	282·5(k)	296·4(k)	3152		3070	3600
Poland	781·5	97·6								12843			
Portugal	182·8	41·1				211·4(k)	231·0(k)	246·1(k)	245·6(k)				
Roumania	641·5	65·8											
Scotland	84·2	10·3											
Spain	1082·8	31·2				786·1(k)	839·7(k)	817·1(k)	990·4(k)				
Sweden	205·0	71·5	340·3	1·22	1·20	386·0	404·6	401·4	384·5				
Switzerland	127·1	9·8	166·0	1·09	1·04	179·8	174·9	204·8	173·1				
Thailand						393·1(k)	396·0(k)	410·1(k)	418·6(k)			2300	3410
Tunisia						48·9(k)	87·4(k)	65·5(k)	54·8(k)				
Turkey	487·1	9·8	517·3	0·98	0·93	606·9	531·1	622·3	718·7	3847	4916		
Union of S. Africa			306·1(d)	1·18	1·09	406·7	381·2	422·1	452·2	2697	3439		
United Kingdom			992·0	1·34	1·22	1229·2	1242·6	1280·6	1247·0				
United States			8595·0(d)	1·15	1·20	12603·4	12180·2	11669·3	11791·8				
Uruguay			156·3(d)	1·15	1·06	155·9	176·9	179·8	185·6				
U.S.S.R.	5473·4	353·3											
Yugoslavia	477·7	66·5								4649			

(a) Belgium-Luxembourg; (b) Included with Belgium; (c) 1935–38; (d) 1935–39; (e) 1936/7–1938/9; (f) India and Pakistan; (g) Included in India; (h) Java only; (i) Not adjusted for oilcake and fish as figures not available; (j) Western Germany; (k) F.A.O. adjusted for fish and whale oil; (l) Adjusted on 1950–1 ratio only.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

overcome by the device of entering only the quantity of grain estimated (from family budget data) to have been available for human consumption, together with the amounts used for brewing and some other purposes, plus net exports or minus net imports. These results may now be regarded as obsolete.

Professor Moore (in *Economic Demography of Eastern and Southern Europe*) has undertaken an analysis of agricultural productivity in which, in effect, he weights the different products by European rather than American prices, thus giving a higher relative weight to grain and a lower to livestock products. He uses farm accountancy statistics to determine net from gross values of production, i.e., makes deductions not only for seed and fodder, but also for fertilisers, equipment and all other expenses of production involving the purchase of goods or services, leaving the true net income of those engaged in agriculture.

F.A.O. measure, in effect, in metric tons of wheat or its exchange equivalent. Multiplying by a factor of 32·7 therefore we can convert their results into I.U. As indicated above, the different weighting leads to considerably different results. The two columns in Table 1 headed "Ratios" are obtained, for two separate periods, by taking as numerator the aggregate value obtained by applying I.U. values to each element of output, and as denominator the F.A.O. result multiplied by the factor of 32·7. To convert to I.U. the F.A.O. values of 1948/9 to 1951/2, the mean of these two ratios is used.

It will be seen how great a difference the choice of weights makes, and how much further work is waiting to be done on this topic.

F.A.O. do not include fishing; and in their reduction for fodders they do not take any account of oilcakes, whether home produced or imported. Their results are therefore adjusted accordingly. The fishing which is included throughout this table does not, however, comprehend whaling.

Some further very interesting results for a number of oriental countries, pre-war and post-war, have been kindly made available by Dr. de Vries, of the International Bank, Washington (privately communicated). He has measured in terms of metric tons of cleaned rice, using for this purpose the exchange ratios prevailing between rice and other commodities within the markets of the country concerned. He is thus, in effect, using an Oriental Unit concept as described above. His results are multiplied by a coefficient of 462 to express tham in Oriental Units as we have them defined here. There is, as has already been made clear, no single coefficient for relating Oriental Units to International Units—if there were, a separate unit would not be necessary—but we may use a factor of approximately 10 when we are dealing with the staple crops, much more when we are dealing with milk, much less when we are dealing with fruit and vegetables.

Product we have defined as the amount of production available "for sale off farm", as the official language has it. In other words, we have deducted the utilization as seed and fodder, and the estimated waste, which occur on the farm. Our product, therefore, represents broadly the amount available for human consumption, before making any provision however for wastes in storage or distribution, but including the industrial utilization of hides, textile fibres, etc., and also a small industrial utilization of foodstuffs (e.g., potatoes for starch); and also some food for consumption by non-farm animals. (The use of horses for urban transport was quite an important element even in the recent past.)

This definition of product is quite a useful and defensible one. It does measure, in a valid manner, the capacity of farming (and fishing) to supply urban needs. But it by no means represents the farmers' real contribution to the national income. We have to take into account the "purchases from the non-farm sector" needed for the purpose of agricultural production—implements, chemical fertilizers, fuel, veterinary services, and a host of other requirements. As will be shown below, these deductions are significant even in the simplest forms of agriculture, and in the most advanced modern agriculture may take a great deal more than half the product.

After making this deduction, the remainder which we still have with us is best defined as "factor income of agriculture". It still does not represent farm income in the ordinarily accepted sense of the word, because it still includes various forms of taxation levied upon land or agricultural production (Britain is one of the few countries in which agricultural land is unrated). The balance does finally represent the income available for distribution, among farmers, farm labourers and land owners. Finally, the real spending power at the disposal of the farming community, depends upon the product of two factors, its net productivity as measured above, and the terms of trade at which it exchanges its products.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Let us consider next the measurement of real product per unit of labour engaged. Our data must generally come from a Census of Population—other measurements of farm labour are often unreliable. From each national census we obtain figures of the number of males engaged in agriculture and fishing, whether farmers and their families, or paid workers. Why only males? It seems that, at present, this is the only way in which international comparability can be maintained. Some countries try to obtain, in their Census, precise information about the number of women that work in agriculture. But in many other countries, including some of the leading European countries, every female member of a farm family is put down as fully engaged in agricultural work. Their figures of agricultural labour force are thereby, by our standards, greatly inflated—perhaps this is the object?

In many countries the definition of the numbers engaged in agriculture and fishing, even for Census purposes, is very uncertain, and also in a number of cases the Census year is already several years in the past, and we have no reliable year by year data to extrapolate its results. In the table which follows, the results are fairly satisfactory for the more advanced countries which have an adequate statistical service, but of a low order of precision for the other countries.

But no results should be read to more than shall we say, one and a half significant figures.

TABLE 2

Real Products per Male Engaged in Agriculture and Fishing, 1949–52

	I.U. per Head		*O.U. per Head*
Argentine	985	Brazil	2,060
Australia	2,180	Ceylon	1,285
Austria	437	Egypt	1,265
Belgium	925	India	585
Canada	1,595	Java	1,400(a)
Chile	265	Pakistan	825
Columbia	265	Peru	1,545(a)
Cuba	552	Philippines	1,000
Denmark	1,319		
Finland	475		
France	581		
Germany	820		
Greece	235(a)		
Hungary	230(a)		
Iceland	2,190(a)		
Ireland	465		
Italy	227		
Japan	220		
Netherlands	992		
New Zealand	4,290		
Norway	1,260		
Poland	200(a)		
Spain	288		
Sweden	654		
Switzerland	535		
Turkey	127		
South Africa	238		
United Kingdom	1,158		
U.S.A.	1,615		
Venezuela	210		
Yugoslavia	150(a)		

(a) 1934–38.

New Zealand has by far the most productive rural economy in the world. When these comparisons were first made, in respect of the period about 1934–35, New Zealand had a substantial lead over the rest of the world; she has now greatly increased it. Second, but a long way second, comes Australia, and then Iceland, with a product almost entirely of fish. U.S.A. and Canada are considerably below these, and only slightly above the most productive European economy,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Denmark. Norway is also largely a fishing economy. Then come Britain and the Netherlands, followed by Argentine and Belgium.

In the countries where the product is measured in O.U. (which unit, in respect of many of the staple crops, represents about one-tenth of an I.U.), the range is also wide, from Brazil, which is comparable with some of the lower figures in the left-hand table, down to India, which has not much more than a quarter of Brazil's meagre output per head.

Lower still, it is generally supposed, are the figures for China. But here, great regional differences are found to prevail. Professor J. L. Buck, in his book, *Land Utilization in China*, works out the average product for each region in kilogrammes of grain equivalent per man equivalent. Man equivalents take account of the labour of women and boys, while grain equivalents

TABLE 3

	Apparent Consumption		1934–38			1950–51		
			Expenditure per Head on Farm Products	*Real Income per Head*	*Price of Standard Ration*	*Expenditure per Head on Farm Products*	*Real Income per Head*	*Price of Standard Ration*
	1934–38	1950–51	(*I.U.'s*)	(*I.U.'s*)	(*I.U.'s*)	(*I.U.'s*)	(*I.U.'s*)	(*I.U.'s*)
	(*million I.U.*)							
Austria	327·6	310·6	48·4	205	107·6	44·3	227	130·3
Belgium-Luxembourg	487·8	554·5	56·6	344	104·2	61·8	518	121·0
Denmark	206·3	288·5	55·4	558	86·8	67·3	626	108·1
Finland	173·0	212·1	47·8	260	93·9	52·4	366	96·6
France	2,327·0	2418·9	56·4	353	112·9	57·4	376	102·9
Greece	259·0	265·6	37·7	193		34·9	150	
Ireland	174·3	199·0	59·0	356	122·9	67·1	436	118·7
Italy	1,380·4	1536·8	32·3	164	106·0	32·9	230	154·7
Netherlands	473·0	568·9	55·1	428	118·3	55·2	503	141·7
Norway	268·8	337·1	92·8	361		102·7	480	
Sweden	383·9	465·4	61·3	415	79·1	66·0	639	102·4
Switzerland	248·7	307·4	59·7	428	88·9	65·1	643	130·4
U.K.	2,967·5	3325·2	64·8	611	111·7	68·1	645	91·1
Canada	819·2	1124·1	72·7	466	107·8	81·0	822	145·2
U.S.A.	9,384·8	11626·4	73·2	639	125·2	76·1	1093	136·0
Argentine	875·0	820·9	64·2	226	78·7	46·6	363	84·5
Brazil	1,310·2	1877·2	34·6	155		36·0	182	
Chile	120·9	185·6	25·4	257	105·0	31·9	266	103·7
Colombia	230·5	415·9	27·5	85		36·9	118	
Cuba	191·8	235·5	44·6	150		43·4	190	
Japan	2,362·5	2019·1	33·7	220		24·1	202	
Union of S. Africa	226·2	386·7	23·5	197	100·3	31·0	284	104·5
Australia	520·4	538·9	76·4	485	88·5	64·9	765	98·1
New Zealand	129·5	151·7	82·3	710	93·9	79·7	958	105·3

are obtained by converting all other products to grain on the basis of the prices prevailing in the local markets—in effect, a procedure similar to that of Dr. de Vries. For each region, however. Professor Buck takes the predominant grain of that region as a base, and to convert his figures to O.U. we therefore have to multiply by different coefficients. The most productive region of China, the south-western rice area, produces 1,830 kilos of rice equivalent, or as much as 846 O.U., per man equivalent per year. The other rice areas are not far below this. In the wheat and millet growing area of northern China, the figure falls as low as 250 O.U. per man equivalent per year. This seems to be not only the lowest level attained anywhere in the world, but also the lowest conceivable.

While we still have our data in the form of aggregates, it is convenient to make our analysis of consumption. To each country's product, built up as it is by summing the I.U. values of each component of output, we merely have to add imports and deduct exports, similarly valued.

A further refinement (not attempted at this stage) would be to make an allowance for the small quantities of farm products incorporated in imports and exports of made-up textile goods, and one or two other finished manufactures.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The obvious procedure is to reduce these consumption figures to a per-head basis, and then express them as a function of real national income per head. The latter figures are obtained from the forthcoming text of the third edition of *Conditions of Economic Progress*. They refer to national income per head of the total population, and not merely of the working population; to *available* rather than *produced* income in countries where those figures differ appreciably; and include the imputed income of farm populations in respect of the home-grown foods which they consume, valued at retail.

To analyse the possible effect of prices on consumption, the price of a "standard ration" of foodstuffs in each country was stated in terms of the number of I.U. of "goods-in-general" which had to be foregone to buy such a ration. (The base of this series is arbitrary.)

It was decided to pool the results* for 1934–38 and 1950–51. They were carefully examined by Mr. A. G. Antill, Demonstrator in Statistics at the Institute of Agricultural Economics, who found that the best fit was a hyperbola of somewhat unusual form, as indicated on Diagram I. We had long been familiar with Adam Smith's generalization that "the desire for food is limited in every man by the narrow capacity of the human stomach"; but it is interesting to have this re-stated as a definite asymptote. In a country with indefinitely high income, according to this relationship, consumption of farm products would not go beyond 114 I.U. per year, or something like £60 at present-day prices, per head. (This of course measures the products at farm, not retail value.)

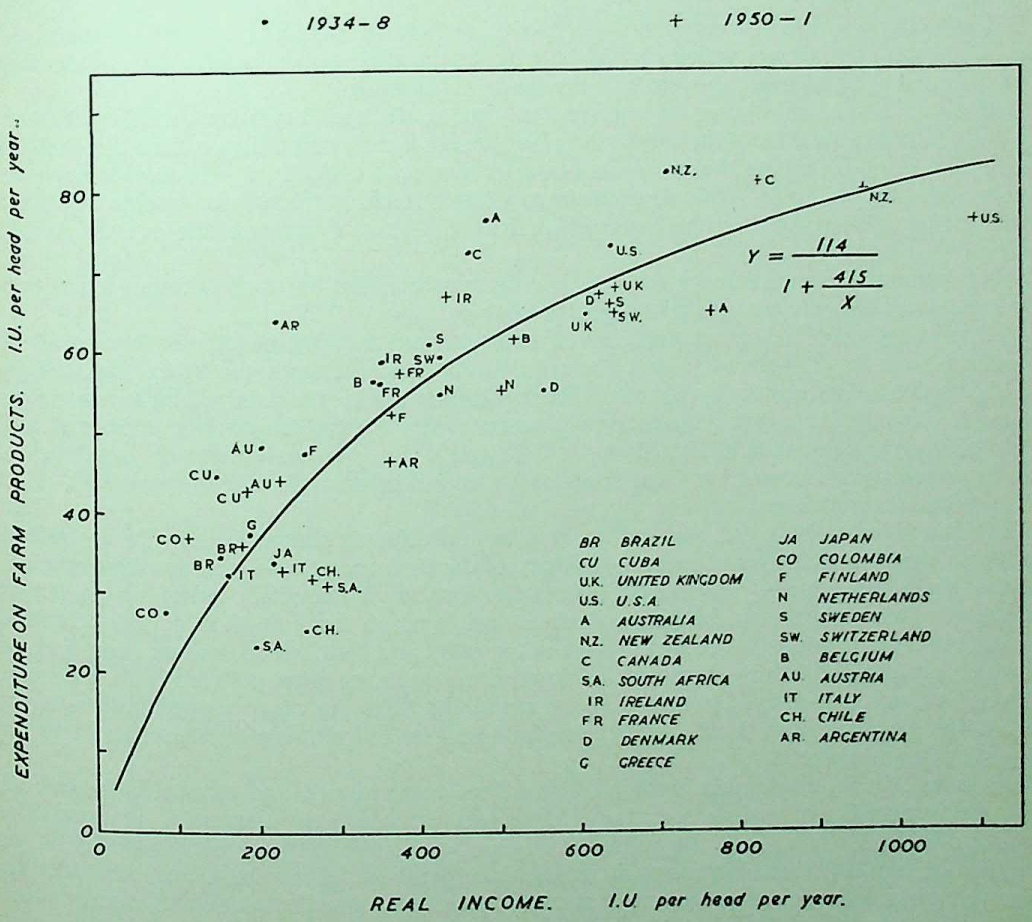


DIAGRAM I

* The calculations omitted the very high figures for Norway (which consumes, at a low local price, a great deal of fish to which a high world price is imputed); the exceptional figures for Greece and Japan; and the low and uncertain figures for Brazil, Colombia and Cuba.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A hyperbola of this nature involves not a constant, but a rapidly declining income elasticity of demand.

Level of Income per Head per Annum (I.U.'s)	*Income Elasticity of Demand*	*Marginal Propensity to Spend on Farm Products*	*Proportion of Income Spent on Farm Products*
X	$= \left(\frac{k}{x+k}\right)$	$= \frac{dy}{dx}$	$= \frac{A}{x+k}$
		$= \frac{Ak}{(x+k)^2}$	$= \frac{Y}{X}$
220	·654	·117	·179
320	·565	·088	·155
420	·497	·068	·136
520	·444	·054	·122
620	·401	·044	·110
820	·336	·031	·092
1020	·289	·023	·079

$k = 415$
$A = 114$

The hyperbola is still not very clearly defined and there are obviously some significant deviations. The first hypothesis which should be tried out is that the deviations are related to the price of food. The data for this analysis are given in the table.

However, before we proceed to analyse our results, we may begin by excluding the U.K., Argentine and Australia from the 1950–51 analysis, as some rationing still prevailed there (indicating that for some foodstuffs the price was *below* market equilibrium). It will also be noted that food consumption in South Africa is exceptionally low in relation to national income, probably a function of South Africa's unusual income distribution. These figures are also omitted from the analysis.

No explanation is available for the very low figures for Chile, but their accuracy is somewhat in question and they are also omitted from the analysis.

A double logarithmic diagram (Diagram II) was prepared showing the price of food in relation to other prices in each country, and the relative difference between the actual consumption, and that calculated from the hyperbola. There is no doubt that the data will be in a downward direction. Two lines are drawn indicating what must surely be near the extreme upper and lower limits of the possible value of this slope, at 0·42 and 0·67. We shall probably conclude that the price elasticity of demand for farm products, in respect of price changes at farm level, is probably above 0·5 and nearer to 0·6.

It is desirable to check this demand analysis from a different source, namely family budgets. We have numerous estimates of income elasticity of demand and general consumption functions, obtained from this source. But almost always the data are in monetary terms, not in physical quantities. Quite apart from the different relative prices which may prevail in different countries, these monetary expenditures include the costs of transport and distribution, and we cannot assume that such costs are relatively constant as between countries, or even between different income groups in the same country. In any large industrial city there are cheap shopping districts, and the families who buy their food there are taking a simpler but cheaper distributive service than those who buy elsewhere.

Diagram III* shows the relationship between food consumption and income as disclosed by family budget studies in various countries. The data from which the diagram is constructed are set out in Table 4. The *I.L.O. Year Book*, 1935–36 gives details of the physical quantity of consumption of foodstuffs and beverages at various income levels. Data for China, Australia and India were obtained from other sources as shown in the table. Income in national currency units and food consumption in kilograms were expressed in real terms by converting to International Units (I.U.'s). Food consumption per head is the result of aggregating the individual items of

* The lower general level of this hyperbola, as compared with Diagram I, is in part explained by the fact that it refers to food only, and does not cover tobacco, textile fibres, etc.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

food consumption after their conversion to I.U.'s. It should be noted that this method gives to each type of food its "real" value in the economic sense—i.e., foods of a higher quality have a higher I.U. value. It is for this reason that the Latin European countries with their somewhat expensive tastes, e.g., France and Belgium, fall well above the line. The rigours of the Indian

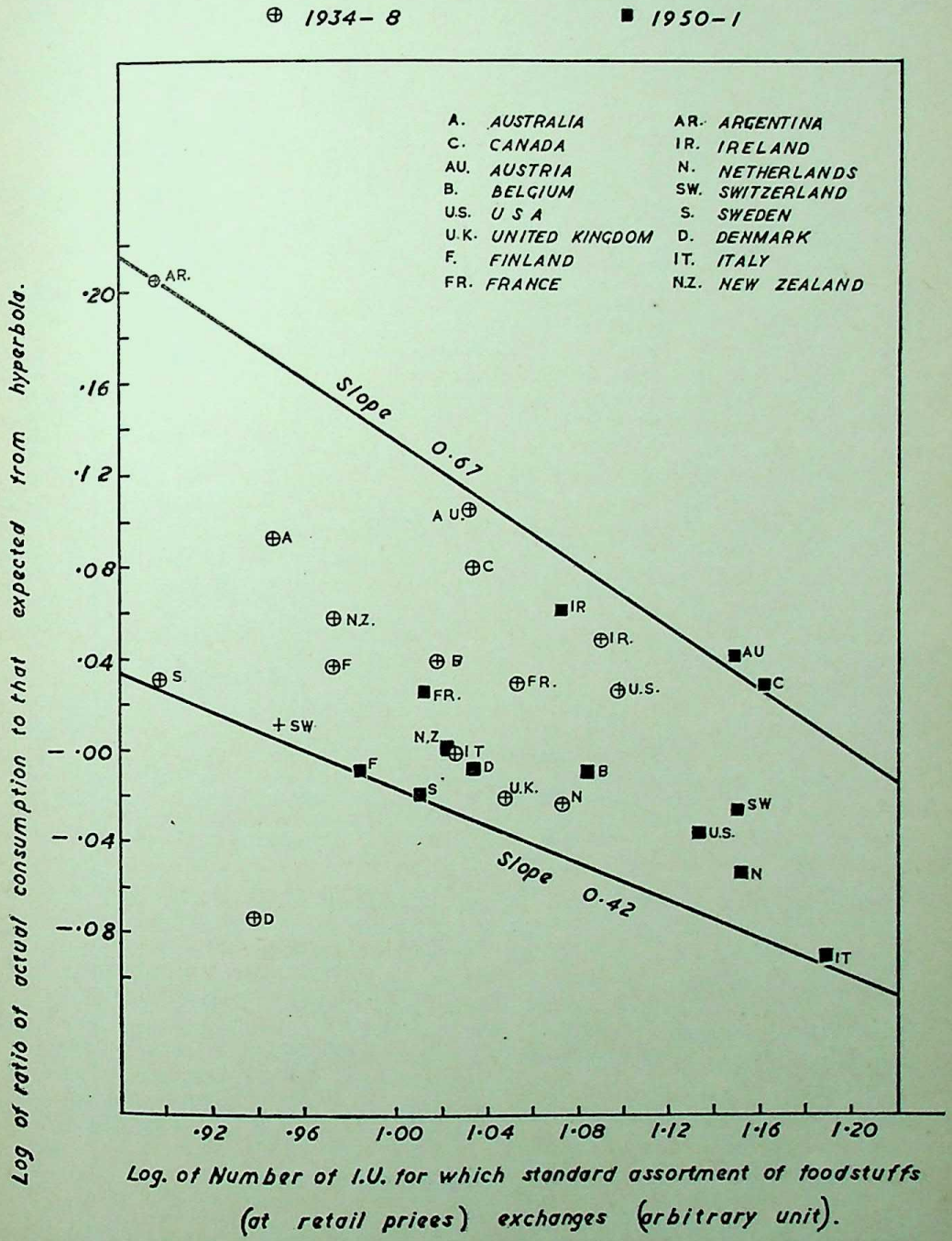


DIAGRAM II

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

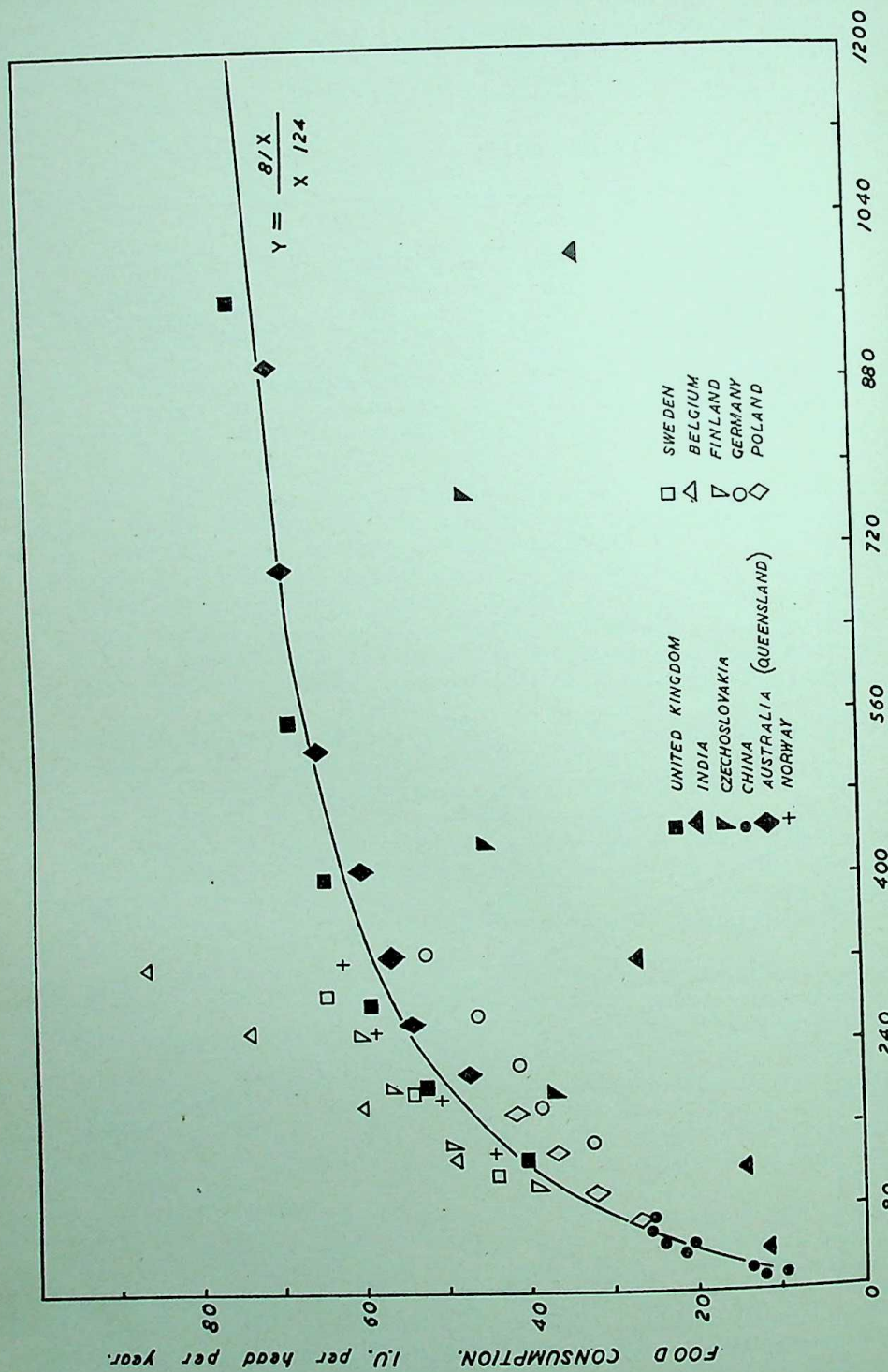


DIAGRAM III

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Food Consumption at Various Income Levels

Country and Year	Income per Head per Annum: National Currency	Income per Head per Annum: I.U.	Food Consumption per Head per Annum (I.U.)
GERMANY, 1927/28	576 (Rm)	144	32·8
	720	180	38·8
	880	219	41·6
	1,080	269	46·8
	1,320	329	52·5
BELGIUM, 1928/29	3,280 (fr.)	129	49·0
	4,550	179	60·1
	6,370	251	73·4
	8,000	315	86·1
FINLAND, 1928	3,600 (Fm)	102	39·5
	5,000	142	49·8
	7,000	198	56·6
	8,800	249	60·4
NORWAY, 1927/28	648 (Kr)	137	44·3
	880	187	50·7
	1,000	254	58·6
	1,520	320	62·3
POLAND, 1929	432 (Zl)	70	26·4
	600	97	32·0
	840	136	36·8
	1,056	171	41·6
UNITED KINGDOM, 1935	20·8 (£)	128	40·6
	32·5	200	52·5
	45·5	280	59·0
	65·0	399	64·4
	91·0	554	68·5
	156·0	960	74·4
SWEDEN, 1933	504 (Kr)	113	44·0
	860	194	54·1
	1,280	287	64·2
CHINA			
Winter wheat millet area		16	10·1
Spring wheat area		17	12·6
Winter wheat—Kaoliang area		24	13·9
Yangtze rice-wheat area		40	22·0
Szechwan rice area		46	21·1
Rice-tea area		48	24·2
South-West rice area		61	25·8
Double crop rice area		70	26·0
QUEENSLAND, AUSTRALIA, 1939–40	47 (£)	211	47·3
	58	260	54·1
	72	323	56·7
	91	408	60·1
	117	524	65·4
	156	699	69·0
	200	896	70·0
CZECHO-SLOVAKIA, 1929–30	3,200 (Kc)	192	37·0
	7,200	432	45·0
	12,800	768	46·8
INDIA		40	11·8
		120	14·2
		320	26·9
		1000	32·7

Sources of data on which the above is based:

India.—Aykroyd, Indian Research Fund Association, Note on the Results of Diet Surveys.
Queensland.—"Family Expenditure Enquiry of 1939/40", *Queensland Year Book*, 1945.
China.—*China's Farm Economy* and *Land Utilization in China* (J. L. Buck).
Other Countries.—"Family Budgets", *I.L.O. Year Book*, 1935–36.

diet may be seen from its position well below the line, even for the higher income groups. The Indian diet, in common with that of most Asian countries, is greatly deficient in animal proteins, which are more expensive than those derived from vegetable foods. But consideration of the low food consumption shown even for high real incomes in India raises three points: (i) the force of religion and social custom, in discouraging the consumption of meat; (ii) whether food requirements may be significantly lower at high temperatures; (iii) if food requirements are to be estimated, as biologists tell us, per kilogram of body-weight, then the low average weight of the Indian population is also a factor which must be taken into account.

The relationship between food consumption per head per annum and real income per head per annum may be represented approximately by the hyperbola

$$Y = \frac{81x}{x + 124}$$

The points representing the Indian and Belgian data are disposed at the same distance from this curve, and some possible explanations for this have already been indicated.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The asymptote, and the income elasticity of demand, as shown by family budgets, are both considerably lower than those shown by national aggregates.

Level of Income per Head per Annum (I.U.'s)	*Income Elasticity of Demand*	*Marginal Propensity to Spend on Food*	*Proportion of Income Spent on Food*
X	$= \left(\frac{k}{x+k}\right)$	$= \frac{dy}{dx}$	$= \left(\frac{A}{x+k}\right)$
		$= \frac{Ak}{(x+k)^2}$	$= \frac{Y}{X}$
20	·861	·48	·561
120	·509	·17	·331
220	·361	·08	·235
320	·280	·05	·182
420	·228	·03	·149
520	·193	·02	·126
620	·166	·02	·109
820	·132	·01	·086
1020	·109	·008	·071

$A = 80 \cdot 9$
$k = 124 \cdot 2$

An exhaustive study of the relation of food consumption to real income per head in pre-war and post-war Germany is made by Dr. H. J. Metzdorf in "Die Stabilität der Verbraucherausgaben für Nährungsmittel" (*Wirtschaftsdienst*, July, 1950). The analysis covers all necessary foodstuffs, but excludes liquor, tobacco and luxury foods. The household budgets examined were those of workers, clerks and higher civil servants. The calculations were made for the four widely different years 1907, 1927/28, 1937 and 1949, income data being recalculated in terms of 1927/28 purchasing power.

The analysis shows that the proportion of real income spent on food, at a given real income level, has remained remarkably constant through all the vicissitudes of the 40-year period under review; and, more interesting still, that the relationship does not differ between social classes.

No worker in this field can lightly disagree with the thorough and careful analysis made by Mr. J. L. Nicholson in this *Journal* (1949, p. 370). Mr. Nicholson obtains income elasticity of demand far higher than those shown by the second hyperbola (International Comparison of Quantities in Family Budgets). From the first hyperbola (comparisons of national aggregates) his results are not so far removed. He finds that the poorer households still have somewhat higher income elasticity of demand than are indicated by this latter curve, the wealthier households (with over £5 a week pre-war) slightly less. His data referred to 1937 and may be a reflection of English eating habits, particularly the tendency to demand meat wherever possible, as compared with other countries. It may be that these tastes have now changed somewhat.

Those who wish to make further comparisons with Mr. Nicholson's tables should use the coefficient that 1*d.* per week of family income per head in 1937 can be equated to 1·21 I.U. per head per year.

In respect of changes in real income caused by changing size of family, where aggregate income is given, income elasticity of demand for food appears to change in about the manner to be expected from the hyperbola.

We are now approaching a position where we can estimate the trend in real demand for farm products in different countries. It must depend upon three factors multiplied together; (i) population trend; (ii) expected upward trend of real product per man-hour; (iii) income elasticity of demand, as calculated above, applied to the second factor. If we wish to refine our result, and have sufficient evidence, we may also take into account expected changes in the ratio of labour force to total population, and of working hours.

Estimates of population trend over the long period are now, to use a vulgarism, anybody's guess. American population experts, with complete unanimity, predicted a heavy deceleration of the rate of population growth for the post-war years. They have been discredited by the facts

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5

	Population in Millions, 1950	*Real Income per Head per Year in I.U.*, 1950	*Expected Percentage Increase*, 1950–75			
			Population	*Real Income per Head*	*Demand for Farm Products per Head*	*Aggregate Demand for Farm Products*
Economically advanced countries (arranged in order of income per head)						
U.S.A.	151·7	1064	54	57	13	74
New Zealand	1·9	958	85	80	19	120
Canada	13·7	810	85	100	26	133
Australia	8·2	723	98	45	14	126
U.K.	50·4	645	5	19	7	12
Switzerland	4·7	638	20	48	16	39
Denmark	4·3	634	28	36	13	45
Sweden	7·0	626	13	100	31	48
Belgium	8·9	516	13	75	28	45
Netherlands	10·1	505	46	43	17	71
Norway	3·3	463	28	66	26	61
Ireland	3·0	441	1	47	20	21
W. Germany	47·7	387	13	81	35	53
France	41·9	372	18	88	38	63
Argentine	17·2	370	54	30	15	77
Finland	4·0	340	37	105	47	101
S. Africa	12·3	284	85	94	48	173
Chile	5·8	266	45	20	12	62
Austria	6·9	253	9	35	20	31
Total						66
Countries of medium income						
Spain	27·9	?	28	17	10	41
Italy	46·3	225	19	68	39	65
Japan	83·2	194	20	65	40	68
Cuba	5·4	193	21	45	29	56
Brazil	52·1	182	87	28	19	123
Greece	7·5	160	45	37	25	81
Portugal	8·5	148	36	28	20	63
Peru	8·4	136	64	62	43	135
Colombia	11·1	118	64	52	38	126
Total of above	250·4					
Total including all medium income countries	484					(70)
Low-income countries	1,347		(35)	(15)	(10)	(48)

with a rapidity and completeness which make the whole of demographic science look rather feeble. In Europe, the demographers were not quite so unanimous; but the present strong upward trend of population in nearly all Western European countries has taken most of us by surprise.

The per cent. per annum rates of growth of real product per man-hour, which have in the past proved to be remarkably constant for many countries, are also taken from the forthcoming text of the third edition of *Conditions of Economic Progress* (they have also been published in the *Bulletin of the Banque National de Belgique*, July, 1953).

This conclusion however is based on an analysis which assumes that the price of farm products, relative to the price of other goods and services, remains unchanged. We have seen from the previous analysis, and we know from common sense, that there is quite a substantial price elasticity of demand for farm products. It is largely on this mechanism that the world will rely to adjust supply to demand. We can state our conclusion in the form that, in so far as aggregate farm output in the economically developed and medium income countries fails to rise at the rate of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 6

	Gross output						Numbers of Males Engaged in Agriculture and Fishing(f) ('000)	Of whom Fishing	Real Product per Head (I.U.)		Materials and Services Used in Agricultural Production Purchased from Non-Farm Sector, per Male Engaged in Agriculture(g) I.U.	Average Hours in Agriculture	Product per Man-hour
	Gross output(a) £m	Less Imported Seed, Fodder and Live-stock(b) £m	At 1911–13 Prices(c) £m	Excluding all Ireland Before 1922(d) £m	m.I.U.(e)	Gross Output Including Fishing m.I.U.			Agriculture and Fishing	Agriculture only			
1867–69	229·8	201·7	174·0	131·8	689	774	1556	39	496	455	139	3200	·142
1870–76	247·2	211·2	176·0	133·9	700	785	1490	43	526	485	151	3170	·153
1877–85	219·2	180·8	165·2	127·2	666	751	1408	61	534	495	167	3120	·159
1886–93	187·8	155·4	172·7	133·4	698	785	1358	55	578	535	172	3080	·174
1894–1903	182·8	146·4	169·8	129·1	675	788	1291	55	610	546	194	3020	·181
1904–10	200·8	161·6	176·0	134·2	702	866	1327	65	652	556	196	2970	·188
1911–13	222·1	177·2	177·2	132·8	694	873	1354	70	644	540	198	2950	·183
1920–22	490·0	409·2	176·5	133·5	698	842	1261	65	667	584	272	2720	·215
1924–29	279·7	208·8	134·3		704	861	1333(h)	64	645	555	259	2720	·204
1930–34	236·5	183·7	145·2		760	914	1295	64	705	617	274	2700	·228
1935–39	279·0	213·8	158·5		829	992	1210	64	820	724	390	2660	·272
1949–52					1105	1257	1084	35	1158	1053	761	2500	·421

(a) Ojala, p. 61. Excluding all crops used for fodder or seed. (b) Data from Ojala, p. 213. Deducting only the farm or port value of fodder, seeds and livestock purchases—in the latter two cases this value is taken at 75 per cent. of the total. (c) From ratios given by Ojala, pp. 208–9. (d) From ratios given in *National Income and Outlay*, p. 246. Northern Ireland remains in the figures from 1924 onwards. (e) Linked on 1935–9 to data given in previous table (857m. I.U., of which 163m. represents fish). (f) Since 1924, including an estimate of 120,000 for Northern Ireland. 1951 data from Census sample. Data back to 1881 from *Statistical Abstract*, 81st issue, p. 128. Data before 1911 reduced by 8·4 per cent. (on information given there) to allow for difference of definition. Data for 1861 and 1871 from Fussell, *Economic Journal*, 1924. Very similar figures for 1861, 1881 and 1901 are given by Lord Eversley, *J.R.S.S.*, 1907, p. 267. Linear interpolation between Census dates. (g) Ojala's figures (p. 213) including distributive margins on fodder, seed, and livestock purchased (whether home-grown or imported), but excluding rates and land tax. His figures for 1935–9 fall £15m. short of Raeburn's and this discrepancy is distributed over the preceding periods to disappear for 1911–13 and earlier. Converted into I.U. by a general price index, and then an unchanging addition of 60m. I.U. made for maintenance of buildings. For the two most recent years, the following comparisons are given in, or can be estimated from, Raeburn's figures, all expressed in £m. of 1951–2 purchasing power:

	Pre-war	1951–2	1952–3
Machinery	34	122	140
Margins on fodder	42	34	35
Margins on seeds and livestock	14	15	15
Fertiliser	20	60	70
Other	49	72	84
	159	303	344
Equivalent in m.I.U.	387	738	839
Add for repair of buildings	447	798	899

The figure given in the column is computed for 1951–2; for 1952–3 it rises to no less than 874 For 1952–3 gross product per man was probably about 1100 I.U.

(h) Note *inclusion* of N. Ireland.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

2 per cent. per annum, a rise in the price of farm products relative to the price of other goods will be necessary; and vice versa.

The "Paley Report" set the example of taking the year 1975 as our base point for future projections. For all the economically advanced countries of the world we have good estimates of the present level of real income and consumption of farm products, some idea of the time trend of real income per head, as yet no very valid ideas about population trend. Of the "medium income" countries, we have to be content with a sample. In these countries (except for the South American countries) the upward trend of population is a good deal less than is commonly supposed. The largest country in this category—Soviet Russia—now appears to have a very much slower rate of population growth than previously, judging from the remarkable silence of Soviet spokesmen on this subject, and from other indications.

TABLE 7

	Income from Agriculture and Horticulture Less Seed and Fodder m.kr.([a])	*Income from Agriculture and Horticulture Less Seed and Fodder Converted to I.U. Millions*([b])	*Deductions for Materials Purchased from Industry, Transport and Depreciation*([b])		*Males Occupied in Agriculture*([e]) ('000)	*I.U. per Male Occupied*		*Average hours*	*Product per man hour*
			m.kr.	*m.I.U.*([d])		*Product*	*Deductions*		
1861–5	204	89·8	12	4	645	139	6	3,520	·039
1866–70	249	101·7	15	5	656	155	8	3,510	·044
1871–5	315	120·8	21	7	670	180	10	3,470	·052
1876–80	334	123·8	24	9	686	180	13	3,460	·052
1881–5	318	123·8	30	12	688	180	17	3,450	·052
1886–90	296	132·9	27	11	677	196	16	3,500	·056
1891–5	356	147·9	37	16	664	223	24	3,420	·065
1896–1900	410	163·5	50	21	650	252	32	3,350	·075
1901–5	457	160·0	70	28	656	244	43	3,250	·075
1906–10	628	186·7	96	35	679	275	52	3,175	·087
1911–15	771	193·7	128	39	697	277	56	3,100	·089
1916–20	1,733	170·8	325	37	709	240	52	3,000	·080
1921–5	1,120	190·7	312	62	711	268	87	2,900	·092
1926–30	1,073	222·6	297	73	704	316	104	2,900	·109
1934–38		323·5			681	475		2,600	·182
1950–51		368·3			565	654		2,500	·262

([a]) From *National Income of Sweden*, Part 1, Table 2 (agriculture) and Table 1 (horticulture). ([b]) Converted to 1861–5 prices by data given by Dr. Ojala, *Agriculture and Economic Progress*, p. 148. The individual items of 1861–5 output, less seed and fodder, revalued directly to I.U., give a total of 89·8m. (of which 31·8 was milk, 20·4 potato, and 8·4 rye). ([c]) From *National Income of Sweden*, Vol. 2, pp. 140–1. A small entry for banking and insurance costs is also included (see Ojala, p. 44). These entries include some costs incurred by forestry and fishing. On the other hand some industrial materials used by agriculture are in the column "Imported Raw Materials", which is not included here. The two errors should be of similar order of magnitude and should compensate each other. However, "industrial materials" still includes such goods as bran and molasses, and the final result, for comparison with other countries, is therefore high. ([d]) Amark's index (from official year book) linked to I.U. in 1929. ([e]) Number of males actually occupied in agriculture, forestry and fishing is known for each Census back to 1900 (the proportion in forestry and fishing is assumed to be the same in earlier years as in 1930): before 1900 has to be extrapolated back on the basis of total population dependent on agriculture. ([f]) For earlier periods, taken as industrial hours + 200.

The low income countries, comprising most of the population of Asia and Africa, are segregated in a class by themselves. We really know very little about either their population trend or their real income trend. (The Indian population trend, which has many people worried, can in fact only be gauged from the decennial census and a few uncertain sample enquiries; the annual rate of growth was 1·5 per cent. per year in 1931–41 and only 1·1 per cent. per year in 1941–51, and many Indian statisticians think that this deceleration will continue. As for China, the best evidence indicates that she is now considerably less populous than she was 100 years ago). Most of their populations still live as subsistence cultivators, and their participation in world commerce, even though it will probably be substantially increased by 1975, will still be limited. The uncertainties

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

in this field therefore do not invalidate the general conclusion that the demand for farm products in 1975, in countries which take part or might take part in world commerce in these commodities, will probably be 60 per cent. or 70 per cent. higher than in 1950—a compound interest rate of increase of about 2 per cent. per annum.

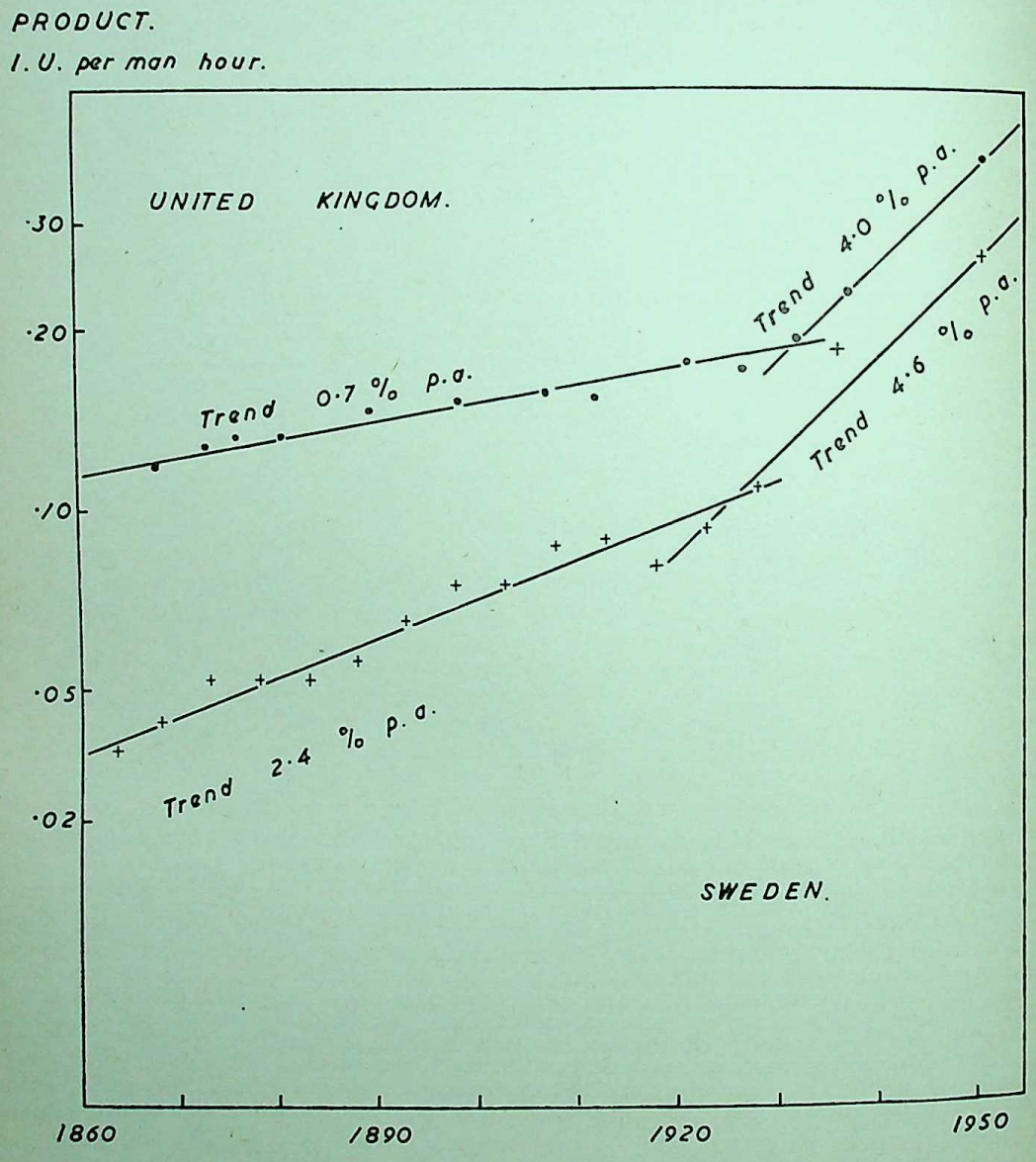


DIAGRAM IV

Now, against these demands we have to balance the world's capacity to produce farm products, and the most convenient way to analyse the problem is to consider separately, (i) the trend of the farm labour force, (ii) the trend of real product per man. (Data generally only show the trend of real product per man year, but possible changes in the working hours of rural workers is a factor which can by no means be neglected.)

The first attempt to make a continuous index for the measurement of real product for British

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

agriculture was that of Dr. Drescher in *Weltwirtschaftliches Archiv* in 1935, making use of the basic data which had been published in this *Journal* by Caird, Craigie, and Rew. Subsequent writers made some alterations to this index; but the whole work was completely revised, brought up-to-date, and linked onto modern agricultural statistics by Dr. Ojala (a New Zealander of Finnish descent) working at the Oxford Institute of Agricultural Economics, in his book *Agriculture and Economic Progress*. For results up to 1939, this book supersedes all previous work, and is very unlikely to be improved upon. We already have an I.U. measurement of British agricultural output for the period 1934–38, and can use Dr. Ojala's series to carry it back to the 1860's.

For post-war years, we have results based on the F.A.O. index, given in a previous table. A slightly more encouraging figure for the trend of real output is given by Dr. Raeburn, of London University, in *Three Banks Review*, December 1953.

Dr. Raeburn's figures also provide by far the best source for costs of production incurred outside the farm sector.

Calculations back to the 1860's are also possible for Sweden. (See Table 7 and Diagram IV.)

There is an interesting agreement of the evidence, from both Britain and Sweden, that some important change, greatly accelerating the rate of improvement of agricultural productivity occurred about 1930. There is independent evidence of this change in the 1930's from the study which Messrs. Graves and Carslaw published in the *Economic Journal* in September 1937. Their results were based on a detailed analysis of a large number of East Anglian farms, but it may well have been in this region that the depressed prices of grain in the 1930's were a particularly strong factor in forcing a transformation. In the five-year period 1931–36 they found a rise in real product per worker of no less than 22 per cent.

The long-period development of British productivity during the 19th century was low compared with that obtained in the United States or Sweden. Even during the so-called "golden age of English farming", before the heavy fall in grain prices in the 1870's, the rise in productivity was also slow. It was a golden age of monetary, not real returns. If we translate McCulloch's approximate output figures for 1837 into these same units, the indication is that real product per man-hour in 1837 was as high as the figure later ascertained for the 1860's. Even Gregory King's carefully compiled estimates for 1688 (which the present writer analysed in *National Income and Outlay*), if stated in these units, showed a real product per man-hour only about 25 per cent. lower than that of the 1860's. What the "Agricultural Revolution" of the late 18th century succeeded in doing was to carry a much enlarged farm population without loss of productivity, rather than to increase productivity per man.

These results give a very different impression from that given by indices based on gross output, e.g., Professor Ashby's paper in the Agricultural Economics Society's Proceedings of 1929, in which he showed a rise of 37 per cent. in real product per man year between 1871 and 1928. This gross output was only obtained by the use of increasing quantities of imported fodder. But a comparatively poor trend in real terms gave rather less discouraging results in monetary terms, for the reason that a substantial change in the relative prices of grain and livestock products made heavy purchases of imported fodder worthwhile.

Much more striking are the results for the United States. (See Table 8 and Diagram. V)

From 1870 to 1940 the upward trend in productivity per man-hour was remarkably steady at 1·6 per annum—a figure very satisfactory by European standards, but below the rate of upward trend for the American economy as a whole. The war years, years not only of increased demand and high prices, but also of special facilities for obtaining new equipment, gave an upward trend which astonished all critics. It was contended that this largely represented the introduction of equipment and methods which had been known in the 1930's but which the farmers could not then afford to instal. By 1949–50 there were distinct signs of a slower rate of growth. But then, touched off perhaps by the increasing labour shortage which came with the Korean war, the rapid upward trend was resumed. From 1940 to 1953 the overall upward trend in real product per man-hour has been no less than 6·3 per cent. per annum, and it shows small sign of deceleration.

The labour force, on the other hand, shows every symptom of accelerated decline. The well-known "Paley Report" (the President's Raw Material Policy Report of June, 1952), estimated that the rural labour force of 1975 would be 10 per cent. below the 1950 level. It has fallen a good deal more than that already. A more realistic estimate for the United States is, that by 1975, the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 8

U.S. Agricultural Productivity

	Farm Output Billion I.U.[a]	*Farm Labour Force*[b] *m.*	*Produce per Head I.U.*	*Average Hours per Year*[c]	*Product per Hour*
1869–71	2·50	6·48	386	3250	·119
1879–81	3·81	8·10	470	3140	·150
1889–91	4·75	9·36	507	3030	·167
1899–1901	6·07	10·26	593	2920	·203
1909	6·46	11·0	588	2811	·209
1910	6·74	10·9	619	2805	·220
1911	6·74	10·8	625	2800	·223
1912	7·42	10·8	687	2795	·246
1913	6·65	10·8	616	2789	·221
1914	7·34	10·8	680	2784	·244
1915	7·51	10·8	695	2778	·250
1916	6·82	10·8	631	2773	·228
1917	7·33	10·6	692	2767	·250
1918	7·33	10·2	719	2762	·260
1919	7·25	10·0	725	2757	·263
1920	7·85	10·2	770	2751	·280
1921	6·91	10·3	671	2746	·244
1922	7·59	10·3	736	2740	·268
1923	7·67	10·2	752	2735	·275
1924	7·67	10·2	752	2729	·275
1925	7·93	10·3	769	2724	·282
1926	8·10	10·4	779	2719	·286
1927	8·10	10·1	802	2713	·295
1928	8·45	10·2	828	2708	·305
1929	8·26	10·4	794	2702	·294
1930	8·10	10·3	786	2697	·291
1931	8·86	10·3	859	2692	·319
1932	8·61	10·2	844	2686	·314
1933	7·93	10·1	785	2680	·293
1934	6·74	9·9	680	2675	·254
1935	8·18	10·11	809	2670	·303
1936	7·25	10·0	725	2665	·272
1937	9·21	9·82	938	2660	·352
1938	8·95	9·69	924	2655	·347
1939	9·03	9·61	940	2650	·354
1940	9·37	9·54	983	2650	·370
1941	9·73	9·10	1069	2700	·396
1942	10·91	9·25	1178	2800	·421
1943	10·66	9·08	1174	3000	·391
1944	11·09	8·95	1239	2800	·443
1945	11·00	8·58	1283	2600	·493
1946	11·33	8·32	1361	2400	·567
1947	10·91	8·27	1320	2350	·562
1948	11·77	7·97	1479	2350	·629
1949	11·68	8·03	1457	2350	·620
1950	11·60	7·51	1543	2350	·657
1951	11·84	7·05	1680	2350	·715
1952	12·28	6·80	1781	2350	·758
1953	12·28	6·54	1879	2350	·799

([a]) Based on 8·52 billion I.U. (U.S. output as given in Table 1, excluding fish) for 1935–9. Official index of farm output, which excludes fodder and farm work animals, since 1910. Earlier years from Messrs. Strauss & Bean, U.S. Department of Agriculture Technical Bulletin No. 703 (1940), p. 126, linked on period 1910–14 (ideal index). Most recent data adjusted in U.S.D.A. *Farm Cost Situation*, March and September, 1953.

([b]) Farm Labour Force, in employment, as estimated by Census Bureau. Since 1935, as published in "Annual Report on Labour Force" or "Survey of Current Business" 1929–34, from *Monthly Labour Review*, December, 1947. 1909–28 "Farm Employment", as published by U.S. Department of Agriculture in *Annual Statistics*, 1952, p. 637, reduced by 10 per cent. to place on a comparable basis with Census Bureau estimates.

Messrs. Barton & Cooper in "Progress of Farm Mechanisation" (U.S.D.A. Misc. Publication No.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

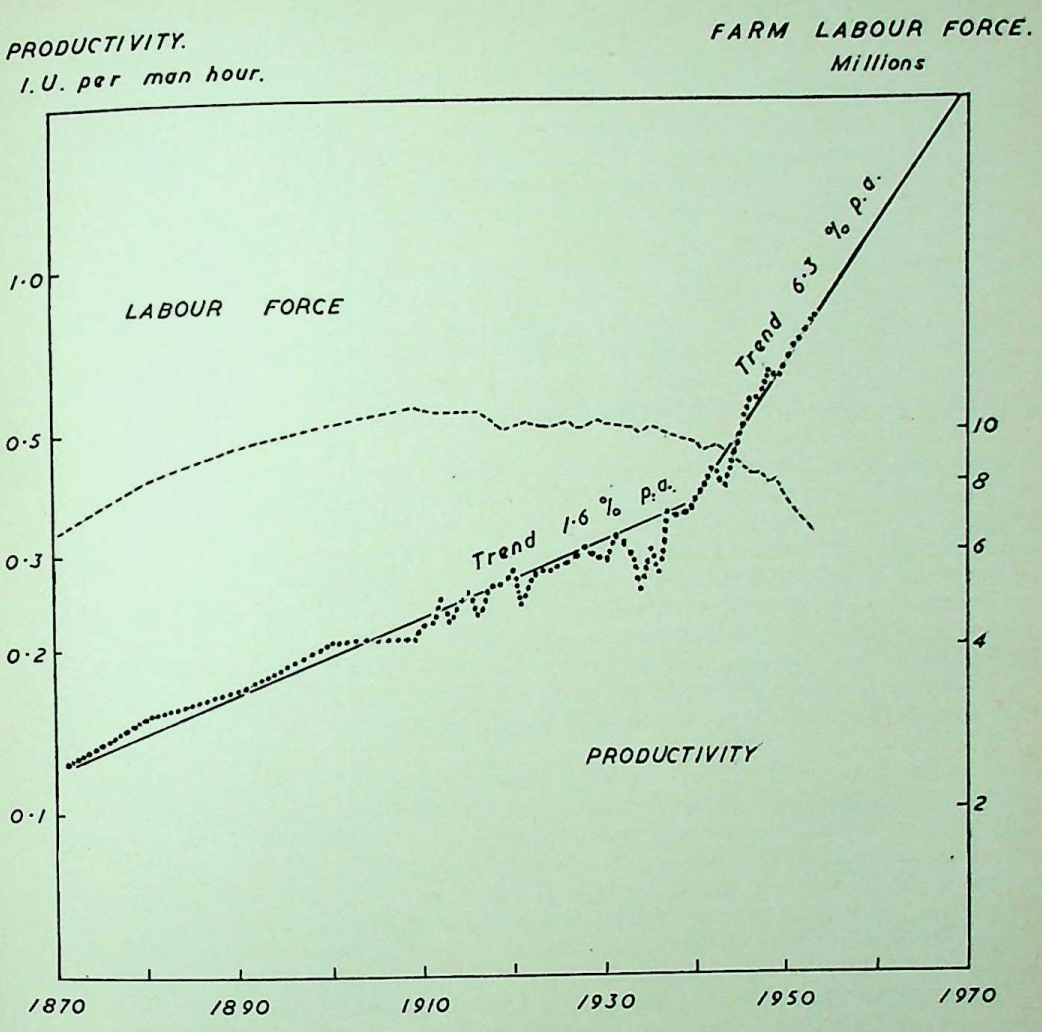


DIAGRAM V

630) estimate farm employment at each Census date 1820–1900 inclusive on a basis comparable with the above. Their figures, also reduced by 10 per cent., are used since 1870. For the earlier years, *before* making the 10 per cent. reduction, their figures show:

	Millions
1820 . . .	2·2
1830 . . .	2·9
1840 . . .	3·9
1850 . . .	5·1
1860 . . .	6·6

(*) Partly assumed. Messrs. Barger & Landsberg (in *American Agriculture*) give 2,800 for 1909–13 and 2,675 for 1932–6. Assumed figure of 3,250 for 1870. Value for 1943 from *Farm Economics*, February, 1944.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 9

Man-hours Required per Year, per Acre, per Animal, or per Unit of Product (for notes see below)

	United States								Britain (h)	Denmark (h)	Finland (h)	Pakistan (aa)	U.S.S.R. (o)	Colombia (n)	Bulgaria (o)	Japan (v)	Formosa (v)	Java (v)	China (m)	
	1940 (c)	1932–6 (d)	1920 (c)	1909–13 (d)	1900 (c)	1880 (c)	1840 (c)	1800 (c)											Man-Hours	Animal Hour
Wheat, per acre	7·5	6·8	12	13	15	20	35	56	36(i)	46	113	120	30	50–175	190				244	81
Harvesting included above	3·8(l)		6·5		8	12	23	40	9–24(i)											
per metric ton	17	20	32	33	40	56	86	137											625	
Maize, per acre	25	24	32	29	38	46	69	86				380	69	90–175	305				269	68
Harvesting included above	10		13		16	18	25	30											2,100	
per metric ton	33	43	44	46	58	71	109	135					330	135–246	605(p)				657	102
Cotton, per acre	98	88(e)	90	105	112	119	135	185												
Harvesting included above	52		35		50	52	45	50											9,170	
per metric ton of lint	840(f)	1,030	1,240	1,240	1,248	1,338	1,932	2,645	172	183	324			262	460				480	80
Potatoes per acre	88(t)	76		89															173	
per metric ton	13(t)	26		33					20(z)	14	61									
Hay per acre	7(g)								27	39	113									
Barley per acre	10(h)								27	39	113									
Oats per acre		8·6		12·5																
per metric ton		24		30																
Rice per acre												680		150(r)		860	420	450	472	124
per metric ton rough rice(b)			36(q)													570	410		292	
Tobacco per acre	444(s)													1,200	3,000					
Market garden crops per acre(u)		113												3,300(k)						
Coffee, dried, per metric ton												120							257	96
Sorghum per acre																			580	
per metric ton															490				246	60
Beans per acre																			778	
per metric ton													52		450					
Sunflowers per acre															440					
Sugar beet per acre																				
Sheep per head	5(j)								3(z)		13									
Pigs, per head	10(j)								14–22(x)		90									
per metric ton meat		93		99																
Milch cows, per head(a)		140		135					120–200(y)		420									
per metric ton milk		73		79							7									
Poultry, per head		2·1							1·9–2·8(w)											

(*a*) Not including labour devoted to calves, heifers and bulls, or to growing feed. (*b*) 1·52 k. rough rice gives 1·0 k. milled rice. (*c*) Messrs. Cooper Barton & Brodell, U.S. Department of Agriculture, Miscellaneous Publication 630. (*d*) Messrs. Barger & Landsberg, *American Agriculture*, p. 258. (*e*) Of the fall between 1909–13 and 1932–6, 6 units were accounted for by the increasing relative importance as cotton growers of states with low real labour costs. (*f*) On a plantation where costs of hand-picking per metric ton amounted to 74 man days, or about half the total labour cost, mechanical picking saved, gross, 86 per cent. of this labour; but only 63 per cent. net, after taking into account the deterioration in the average quality of the cotton consequent on machine picking (National City Bank of New York, *Monthly Bulletin*, January 1945). (*g*) Harma, *Farm Economics*, March, 1953 (for New York State). According to *Farm Economics*, April, 1945, the man-hour cost of moving one ton of hay from wind row to barn is 5·0 by hand-loading, 3·2 with a power fork, 1·4 with a piick-up baler. (*h*) Harma, *Farm Economics*, March, 1953, except where otherwise indicated; present-day figures. (*i*) Cambridge University Farm Economics Branch Bulletin 9 indicates 10 man-hours per acre other than harvesting and for harvesting ,9·3 man-hours per acre by self-propelled 12 ft. combine, 11·7 by smaller combine, 14·4 by binder with threshing in the field, and 23·6 with threshing from the stack. Harma has apparently based his figure on this latter method, which is now disappearing. (*j*) Harma, *loc. cit.*, referring to New York State. Per sow, 30 man-hours of labour per year is allowed. (*k*) In Guatemala (Higbee, *Geographical Review*, April, 1947). (*l*) An interesting investigation carried out in the Argentine in the 1920's (*International Labour Review*, vol. 25, p. 525) showed man-hour costs of combine harvesting as here, irrespective of the weight of the crop, while costs of harvesting with reaper and binder were almost directly proportional to the weight of the crop. With the average Argentine crop of only 9 quintals to the hectare, per acre costs of reaper- and binder-harvesting were only ¼ higher than combine harvesting. With a European-weight crop, however, they would be nearly 2½ times higher. (*m*) Dr. Buck, *Chinese Farm Economy*. (*n*) *Foreign Agriculture* (Washington), June–July, 1946. The lower figures give the cost of tractor cultivation. (*o*) Dr. Jasny, *Foreign Agriculture*, January, 1947. (*p*) 262 horse-hours or 405 ox-hours required also. (*q*) Cole, *Quarterly Journal of Economics*, 1927. (*r*) Tractor cultivation. (*s*) Estimate for Southern States (*Foreign Agriculture*, June–July, 1946). (*t*) Figures for 1944–8 from *Farm Economics*, September, 1950. This source also gives figures for 1914–18 which agree closely with Barger & Landsberg's figures for 1909–13. (*u*) *Farm Economics*, February, 1944 gives the following figures for certain leading market garden crops in New York State:

	Man-hours per Acre			
	Green Beans	*Tomatoes*	*Sweet Corn*	*Peas*
Cultivation	24–48	38–60	15–17	7–8
Harvesting	195–302	107–128	18–24	8–11

(*v*) Results given in man-days (assumed to be of 10 hours) from Boeke, *The Structure of the N.E.I. Economy*, 1942, and for Formosa and Japan, Te Tsui Chang, *Land Economics*, November, 1952: data refer to 1931–4. (*w*) 1·9 yard and litter system, 2·6 free range, 2·8 battery. (from *Some Economic Considerations of Commercial Egg Production*, 1951–2, Cambridge University). (*x*) 14 indoor, 22 outdoor (from Watson and More, *Agriculture*). (*y*) Lower figure is for herds of 60 or more, higher for 10 or less (from National Investigation into the Economics of milk Production). (*z*) *Utilization of Labour on Farms in Wales*, by Dr. O. T. Price, University of Aberystwyth, 1947. For baled hay, the figure is 33. (*aa*) Deduced from *Farm Accounts in the Punjab*, 1942–43 (Punjab Board of Economic Enquiry, Lahore).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

rural labour force will be down to about 2 million and we may also well assume that they will work a 40-hour week or 2000 hours a year. Even with the upward trend in real product per man-hour continuing at the full present rate, this indicates an aggregate product by 1975 of 11·2 billion I.U., or below the present level. With a rapidly rising population, and with demand per head still rising, the United States will find her farm surpluses, though embarrassing temporarily, no permanent problem. The United States already imports very large quantities of farm products, particularly sugar, coffee and wool, but will be a greatly increased importer in the next two decades.

We can analyse these productivity trends in more detail by measuring the changes in the number of man-hours needed to cultivate an acre or to provide for a farm animal. These are based, not on national aggregates, but on surveys of individual farms. They tend to represent the "best" methods, that is to say, not merely the best results achievable under experimental conditions, but the best methods available in practice to an intelligent contemporary farmer. Many individual farmers, whether through lack of knowledge, or lack of money to buy equipment, or for any other reason, fall short of these standards. Circumstances which enable the poor farmer to catch up with the good may be a more important factor in agricultural progress than technical improvements themselves.

So far we have measured increases in gross product per man ("gross" in the sense that we have deducted only the seed, fodder and livestock used up in the actual process of agricultural production, and no other materials or services used). From the point of view of measuring agriculture's ability to supply the world's need of farm products, this is the most important thing to measure. But these rapid increases in gross output are involving also a great increase in the use, in the process of agricultural production, of goods and services from the non-farm sector. We should attempt a closer measurement of this, firstly in order to demonstrate that the net income of the farm population is rising much more slowly than its gross product, and secondly to get some idea of the increasing demand for fertilizers, farm equipment and similar commodities.

This measurement amounts in effect, statistically, to measuring what can be called "non-factor costs" in farming.

These great increases in productivity have only been obtained by methods which involve a complete break with the old methods of farming. The nature of this break can be most clearly understood if we bear in mind that the old-fashioned farm (including the old-fashioned English farm as it was until quite recently) strove for the highest possible degree of self-containedness. While certain implements had to be bought, the farm produced its own motive power, its own manure, its own fodder, its own fencing material, did much of its own repair-work on buildings and equipment, doctored its own animals. It was indeed this self-containedness of farm life (stretching back, probably, in modified but unbroken continuity to the "villa" which preserved a nucleus of civilization in the barbarism of the Dark Ages) which accounted for its fascination for so many cultured minds. The farmer is now almost at one with the business man and industrialist, buying one set of commodities in order to transform them into another; and in the short space of twenty years this transformation has been extremely rapid.

We can define as factor payments all payments of the following nature:

Drawings in cash or kind by the producer and his family.
Wage and salary payments.
Rent.
Interest.
Taxation.*

The sum of these "factor payments" is sometimes called (e.g., by Dr. Carslaw of Cambridge, in his paper to this Society in 1935) the "social income" of agriculture, though they may appear as costs to the individual producer. The "social cost" incurred by agriculture is represented by its payments other than these "factor payments".

These include fertilizers, depreciation and maintenance of all buildings and implements, materials for fencing and draining, small tools, hire of equipment, containers, the transport of

* There might be some case for separating from the taxation figure an estimate of the cost of providing those public services (e.g., roads), which are specifically designed for the use of the farming community, and without which agricultural production, on its present scale, could not be carried on. Even so, it is still necessary to make a distinction between the use of such road and other services for purposes of production, and their use by the farmer and his family for household or recreational purposes.

1952: data refer to 1951–4. (*b*) 1·9 yard and liter system, 2·6 tiers. 2 Calculated from data for herds of 60 or more higher for 10 or less (from National Investigation into the Economics of milk (*a*) 14 indoor, 22 outdoor (from Watson and More, *Agriculture*). (*c*) Lower figure is for herds of 60 or more higher for 10 or less (from National Investigation into the Economics of milk Production). (*c*) *Utilization of Labour on Farms in Wales*, by Dr. O. T. Price, University of Aberystwyth, 1947. For baled hay, the figure is 33. (*aa*) Deduced from *Farm Accounts in the Punjab*, 1942–43 (Punjab Board of Economic Enquiry, Lahore).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

requirements to the farm and of produce to market, insecticides, payments for certain services such as insurance, telephone and veterinary treatment, and a host of minor expenses.

How far the cost of running a farmer's motor car should be treated as a cost of agricultural production is a question which must be arbitrarily settled; and agricultural economists are often content to follow the income tax administration rulings which impute about half of such costs to production, and the other half to household use.

Purchases of fodder, live stock and seeds are omitted because they represent the output of other farmers. However, an allowance should be included here for costs of transport and merchanting incurred by such goods passing between one farmer and another.

There is only one of these costs which we can hope to measure for all countries and that is the cost of fertilizers. The consumption of fertilizers in their various forms in each country has been analysed down to their essential components (nitrogen, phosphorus and potassium) and we can re-express these as real values of fertilizer consumption measured in I.U.

Of purchases of fodder, live stock and seeds as stated above, a certain proportion represents the cost of transporting, merchanting and processing such goods. In the United States, a comparison of the prices paid by farmers* for various feeds with the prices received by farmers for the raw grain or hay from which they are produced, indicates that some 25 per cent. of the prices paid by farmers represents transport and merchanting costs.

The following costs are extracted from *Agricultural Statistics*, 1952, p. 701.

	Dollars (Million)				
	1910	1920	1929	1939	1951
Operation of vehicles, maintenance and depreciation, "other expenses" . .	1,236	3,379	2,806	2,376	8,682
25 per cent. of expenditure on feed and live stock	156	423	365	303	1670
	1,392	3,802	3,171	2,679	10,352
Numbers occupied (millions) . . .	10·9	10·2	10·4	9·61	7·05
Expenditure per head (dollars) . .	128	373	305	279	1469
Prices, 1925–34 (base)	·606	1·345	1·08	0·895	1·755
Expenditure (I.U. per head) . . .	211	278	283	312	838

For New Zealand we have an interesting survey† computed in pence per lb. of butter fat on dairy farms. The Minister for Marketing in that year estimated an average output of 4,540 lbs. of butter fat per year per full-time male equivalent. A recent survey had shown a somewhat lower figure, but this was believed to cover some men not fully engaged in farming. Each penny per lb. of butter fat therefore equals £18·9 or 98·4 I.U. per man-year. Miscellaneous costs amounted to 3·231 pence per lb. If we estimate in addition that 25 per cent. of fodder purchased represented non-farm handling charges, this figure is raised to 3·300 pence or 325 I.U. per year per male engaged.

In Germany also careful official records of farm costs have been kept.

	1928–29	1937–38
Miscellaneous costs, million reichsmarks	2,152	2,274
25 per cent. of fodder purchased	379	210
	2,531	2,484
Per male engaged in agriculture, reichsmarks . . .	548	590
,, ,, ,, International Units . .	133	207

An estimate for France was published by Études et Conjoncture in December, 1947, using some unpublished work by M. Klatzmann. At that time, the post-war figures had not recovered, in real terms, to the 1938 level of 14·5 billion francs, equivalent to 5·95 million I.U., or 141 I.U. per man engaged.

The Polish national economic plan published in 1947 estimated non-factor payments for 1937, excluding seed, fodder and fertilizer, at 700 million zloty, i.e., 128 zlotý or 37 I.U. per man engaged.

In Japan, semi-official estimates are prepared of the costs incurred in rice growing. In real

* *Agricultural Statistics*, 1950, p. 633.
† *New Zealand Year Book*, 1938, pp. 447–448.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

terms these non-factor costs per hectare were the same in 1951 as in 1929, i.e., about 50 I.U. per hectare, or 65 I.U. per man.

Besides these national aggregates, interesting results can often be obtained from hypothetical farm accounts drawn up by well-informed estimators.

In preparing the plans for the Thal Irrigation Project in Pakistan (United Nations, Formulation and Economic Appraisal of Development Projects), a 15 acre farm on sandy loam soil with a gross return of 1,520 rupees per year was expected to have the following non-factor costs (rupees per year):

Agricultural	(*Rupees*)
Seed	100
Fodder	100
Depreciation of bullocks	40
	240

Non-Agricultural	*Rupees*
Water Charge	75
Repairs	25
Bullock shoeing and veterinary service	24
Miscellaneous	46
Depreciation—	
Of Buildings	20
Of Implements	20
	210

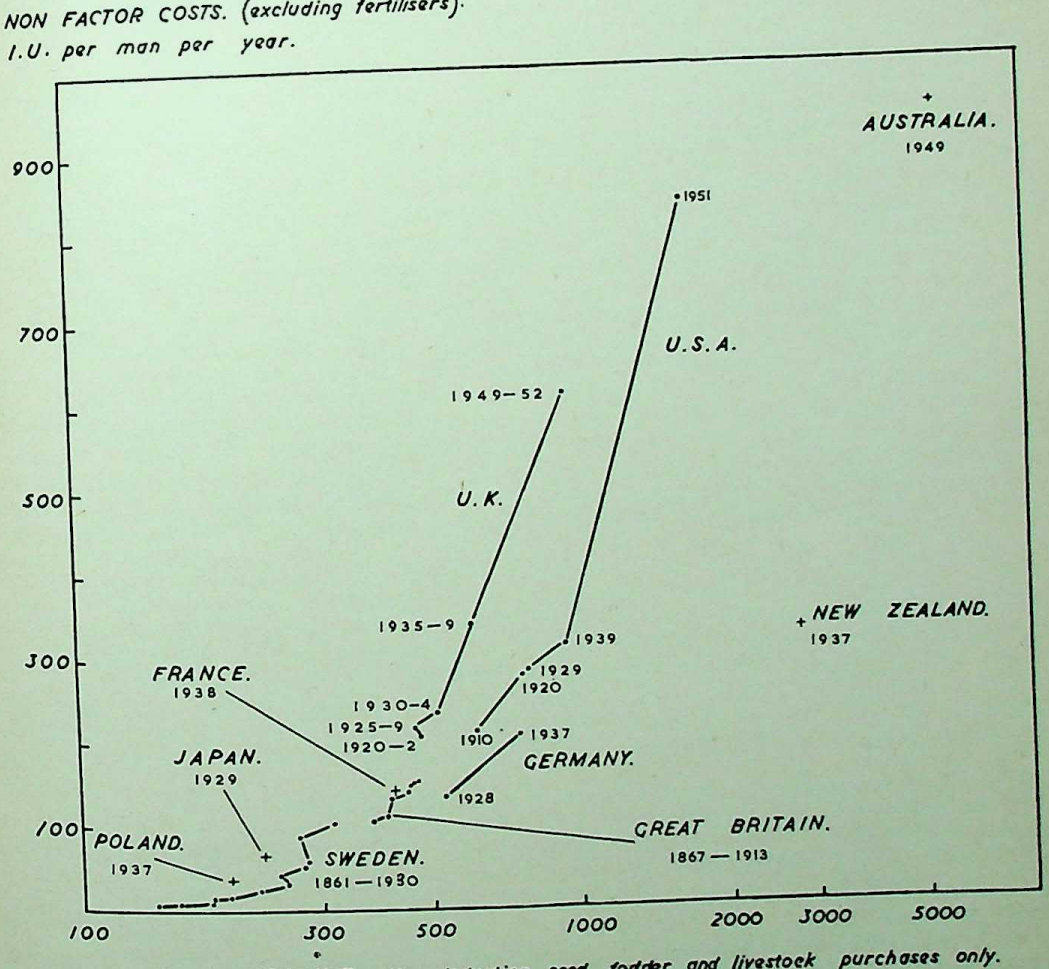


DIAGRAM VI

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Western Australian Department of Agriculture in 1949 published an official estimate of costs and returns on a 2,000 acre property employing two men (or, say, the equivalent of 2¼, including shearers and casual labour).

Expected output:

			I.U.
Wool, greasy	lbs.	10,000	2,565
Sheepskins	No.	50	120
Fat Sheep	No.	350	3,000
Wheat	bush.	7,000	6,230
			11,915

Non-factor costs were £245 on fertilizer, £350 on fuel and £920 other. The two latter may be equated to 2,120 I.U. or 943 per worker.

Non-factor costs in Britain rose little between 1867 and 1918, and still less up to 1930. Since then they have risen with an almost alarming rapidity, though less steeply than in the United States. What is disquieting is that, at a *given level* of non-factor costs, the British farmer seems to obtain considerably less output than the American, and far less than in Australia or New Zealand.*

They are expressed in I.U. by means of coefficients which allow for the costs of transporting and distributing as well as manufacturing them.

Consumption of Fertilizers I.U. per Year per Male Engaged

	1934–8	1950–1
Argentine		2
Australia	71	128
Austria	6	11
Belgium	74	88
Brazil	—	—
Burma	—	—
Canada	9	27
Ceylon	2	4
Chile	4	6
Colombia	1	2
Cuba	3	3
Cyprus	—	—
Denmark	67	82
Egypt	7	10
Finland	11	22
France	29	33
Germany	94	70
Greece	4	10
Hungary	2	
Iceland	10	
India	—	—
Ireland	9	21
Italy	13	10
Japan	26	19
Java	1	
Netherlands	96	118
New Zealand	110	206
Norway	24	56
Pakistan	—	—
Philippines	—	—
Peru	12	
Poland	37	
Sweden	31	48
Switzerland	8	18
Turkey	—	—
Union of South Africa	9	158
United Kingdom	41	129
United States	25	90
Venezuela	—	—
Yugoslavia	—	—

— Indicates very low figures. Blank space = no information available.

* The diagram may give a misleading impression that Australian Productivity per man is higher than in New Zealand, whereas in fact the reverse is the case. The Australian data in the diagram not only refers to a later date than the New Zealand, but refers only to a particular type of farming in Western Australia, whereas the New Zealand figure is a national aggregate.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

I.U. Values of Fertilizers

Per ton of 2,000 *pounds in U.S.A.*

	Price in $ Wholesale, 1925–34	*Distributive Margin, 1949*		*I.U. Value on Farm*	*Per Metric Ton I.U.*	*Per Metric Ton of Plant Nutrient I.U.*
		$	*I.U.*			
Sodium nitrate	40·5	13·3	8·9	49·4	54·4	329(N)
Ammonium sulphate	38·8	29·4	19·6	58·4	64·4	322(N)
Superphosphate	8·5	16·7	11·1	19·6	21·6	135(P_2O_5)
Muriate of Potash	12·1	30·3	20·2	32·3	35·7	59(K_2O)

It is interesting to see that New Zealand shows much the highest figure of consumption per man engaged, though the Netherlands leads in consumption per acre. It is interesting to see how low consumption still is in many countries.

Discussion on Mr. Clark's Paper

Mr. Campion: I have great pleasure in proposing a vote of thanks to Mr. Clark and in welcoming him back to meetings of the Society.

In his paper Mr. Clark has raised two problems. The first is how to make international comparisons between countries, and the second, how to estimate future supplies and requirements.

On the first of these, Mr. Clark uses his device of "international units" defined as "the quantity of goods exchanged for dollars in the United States over the ten years 1925–34." Mr. Clark is apparently not satisfied with this unit now. He also does not like the F.A.O. choice of taking the export prices in 1934–38. He is experimenting with an Oriental Unit. Would Mr. Clark like to suggest what he considers the appropriate years and the commodities to cover for a suitable post-war basis?

The selection of weights in making these comparisons is difficult and his first text table shows what differences it can make. There are considerable differences in the relative importance of different commodities, depending on which of the three bases is taken. For example, in the F.A.O. scale, the ratio of wheat to mutton and lamb is 1 : 6. For Mr. Clark's "International Unit", the ratio is from 32·7 : 271–1 to about 8; for his "Oriental Unit" the ratio is 332 : 2,750; between 1 : 8 and 1 : 9. There are similar divergencies between other commodities. The resulting ranking of countries in Table 2, based on Mr. Clark's "International Units", would appear therefore to favour the countries producing livestock products and commodities such as butter and this probably explains in part the high rank of New Zealand and Australia compared with, say, the United Kingdom.

There are other statistical differences in making the kind of international comparisons in Table 2. Mr. Clark himself mentions the difficulty of deciding what is "food" or a "farm product". Mr. Clark includes butter and cheese as a farm product but omits raw silk, while the F.A.O. scale excludes butter and cheese and includes silk. There are also difficulties in deciding what countries regard as "output" and what is the appropriate unit for agricultural labour. Mr. Clark uses real output per adult male and ignores all female labour employed in agriculture. This means that insofar as the proportion of women to men in agriculture tends to be larger in the less developed agricultural areas, the figures of real output in Table 2 understates the disparity between different countries.

The whole question of making inter-spatial comparisons between countries is a most complicated and hazardous business and those who have to do it for necessity have to be careful not to fall so much in love with the arithmetic that they cannot pull themselves up in time to realize that some comparisons are not possible. Apart from the study on levels of consumption done in 1944 between the United States, Canada and the United Kingdom, there has been a number of exercises of this kind since then for assessing contributions to different international organizations and for measuring the defence burdens of different countries. Recently a very interesting study has been undertaken by O.E.E.C. and their publication stresses many of the difficulties encountered, even if sufficient statistical data are available to start on such comparisons at all. The kind of difficulties are: whether exchange rates are really in equilibrium. What is the relation between internal prices and exchange rates? What is the difference between retail prices and landed prices? How far are retail prices affected, for example, by indirect taxes and subsidies? Can comparisons be

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

made when, in fact, commodities consumed and commodities produced differ widely between country and country? There is also the technical question how far it is possible to produce a single set of results. Before the war Mr. Clark used to have great respect for the use of the ideal formula for this purpose. It has recently been contested in the work of O.E.E.C.

Many of these difficulties do not, however, apply with so much force when comparisons are being made over time, as is done in the latter part of Mr. Clark's paper, in making estimates of future supplies and requirements.

Table 5 presents a summary of his results. It is not exactly clear what assumptions he has made in arriving at the figures in the fifth column of Table 5 on "demand for farm products per head". He appears to have disregarded changes in the distribution of incomes within each country and merely to have taken the average income per head in each country and found its place on the hyperbola given in the text above Table 5.

Mr. Clark's results for future supplies and requirements can be read against a recent report on European agriculture prepared by the Economic Commission for Europe and the Food and Agriculture Organization. Perhaps the most obvious omission from Mr. Clark's analysis is that he has spoken mainly of output per head of persons employed and said little about productivity in the sense of output per acre. The report of E.C.E. and F.A.O. shows that although level of labour productivity in agriculture in Europe is probably lower than in overseas countries, such as the United States, Canada and Australia, the European countries have a higher productivity per acre than those countries. Mr. Clark has only put a tentative estimate in Table 5 of the possible rise in demand for farm products by the "low income countries" which account for 60 per cent. of the population of the world. One of the main problems for the future is what will happen in the Asian countries which have half the population of the world and only one-fifth of the world's agricultural land.

Professor DUDLEY STAMP: It gives me great pleasure to second the vote of thanks and to express my gratification at being invited as one from another field of inquiry to participate in this discussion. Mr. Clark has anticipated one or two points which might obviously come from a geographer like myself. I am more accustomed to discussing these matters in the company of agriculturists and the real difficulty which I feel is that there are many people working in this enormously important field of world food production and world population and they do not seem to meet on any common ground. The difficulty seems to be expressed in the title of the paper "World Supply and Requirements of Farm Products", and in the use of the unit "I.U." for the measurement of the agricultural output of most countries and "O.U." for the oriental unit representing the quantity of goods exchangeable for an Indian rupee. The differences are found in the production per man engaged in agriculture. The proposer of the vote of thanks has reminded us from the world point of view of the upward trend of world population. There is an annual net increase of at least 1 per cent. in the world population which means that 25 million more people have to be fed each year, and beyond this there is the figure for an anticipated increase of demand due to improved standards of living. There is no doubt whatsoever that at the present time half the enormous population of the world is suffering from low diet and is at or near starvation level or definitely undernourished. The problem before us is the increase of output per unit area. What I sincerely hope is that somewhere we can reach common ground. There are two considerations which should be brought together, namely, the output per man or per man-hour and the output per unit area.

Fellows will remember Professor Kendall's paper on crop productivity in the counties of England and the interest which that paper has stimulated in various directions. Two or three years ago I tried to apply Kendall's Ranking Coefficient to those major countries of the world of which one has more or less complete information and to form an estimate of efficiency in output per unit area. I took twenty of the leading countries. At the top of the list in productivity were Belgium, Denmark and Holland, a little lower the United Kingdom and New Zealand, and, a long way down the list, the United States and Canada, whilst right at the bottom were Australia, India and Spain. I realized at once what an enormously different view one gets of agricultural efficiency by taking the output per unit area. The result is influenced, of course, by a number of factors, of which climate is one. We have in this country, some would claim, the best climate for productivity in the world. The low figure for Australia is doubtless due to vagaries of climate, that for India may be ascribed to other causes; the low Spanish figure is due to a combination of social and climatic factors. As I myself said when I was in America two years ago, if we look for an increase in world food production the easiest way is to consider one of the still most underdeveloped of all the great agricultural countries, the United States.

I do not know whether it is possible to state for one human being the area of productive farm land which is necessary to support him. I believe from the calculations already made that $1\frac{1}{8}$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

acres, taking the world as a whole, are required to supply food for one person. That, of course, is taking a tremendous range of both requirements and output per individual. In the United States from 3 to 3½ acres are regarded as necessary, instead of the 1⅛. In Great Britain, as is well known, almost exactly one acre is necessary.

Diagram V in the paper showed the recent increase in output in international units per man-hour in the United States and the result is exactly what I should expect. The United States produces roughly two-thirds of the corn (i.e. maize) in the world and in the 'forties the productivity per acre increased by 50 per cent.—one of the most spectacular rises on record. Is not that primarily the result of the application on a very large scale of scientific principles, in this case the use of hybrid corn with high yields?

I feel incompetent to comment on the paper as a whole but if I may mention one other point it would be with regard to units of comparison. The difference which is suggested by the units I.U. and O.U., is the same as always occurs in comparing the temperate regions with the tropics. Not only does a different range of products come in but there is a completely different attitude to male and female labour. Recently I was listening to a lecture on rural depopulation in parts of Africa and it was stated that the main reason for such depopulation was that the men left the countryside not merely to earn more money in urban centres but because they thought agricultural work derogatory and something which might be left to women.

Finally I wish to express my appreciation of a paper containing so much that is stimulating and of general interest.

The vote of thanks was put to the meeting and carried unanimously.

The CHAIRMAN said that Mr. Clark had pointed out that experts who had predicted future trends of the population had been at fault because the hand that rocked the cradle had deliberately taken steps to rock it more often. He wondered, at the other end of the scale of natural phenomena, how far estimates of agricultural productivity would be changed if the rabbit population of this country were wiped out by myxomatosis.

Dr. E. C. SNOW said that older Fellows of the Society very greatly appreciated Mr. Clark's kindly reference to Sir Alfred Flux, who did much valuable work for the Society between the wars when in charge of the Statistical Department of the Board of Trade. He (Dr. Snow) had had contacts with high Civil Servants in three very different phases. Before the first war they appeared to have few official duties and ample time to spare on outside interests even between the working hours of ten and four. At that time, one of the Honorary Secretaries of the Society—a Civil Servant—had sufficient time in the morning to go through the correspondence of the Society and indicate the replies to be given and to receive them back later for signature. In addition he contributed a good deal to the proceedings of the Society. Between the wars conditions were harder for Civil Servants but Sir Alfred Flux and others (particularly Mr. H. W. Macrosty) had sufficient leisure to do a good deal of the administrative work of the Society and to provide papers and reviews for the *Journal*. In recent years, however, even the leisure of high Civil Servants had been encroached upon by further official duties, and it was a matter for regret that contributions from them had suffered in consequence.

Dr. Snow said he was greatly interested in Table 8 in Mr. Clark's paper. The productivity figures for agriculture from 1910 onwards brought back to mind the first piece of work he had done in connection with the Society. There was great concern in the few years before the 1914–18 war at the heavy emigration from this country of people in the prime of life and at a time when the birth rate was falling rapidly and it was already clear that we were heading for a rapid increase in the proportion of elderly people compared with those of working ages. Consideration of the effect of emigration on the conditions of the population at home was among the terms of reference of a Royal Commission—the Dominions Royal Commission—of which Sir Rider Haggard was a member. Sir Rider—who was not statistically minded—seemed particularly worried and pictured in graphic terms the state of living in a future in which there would be a great preponderance of old people and relatively few to provide the food and do the work for them. The war not only cut off the work of the Commission but produced many other results not then foreseen, and actual life in 1954 was certainly pleasanter than the novelist portrayed it to his fellow members on the Commission 40 years before.

Mr. Clark's table showed that in fact there was little real ground for the worry which was fairly widespread at the time. But at that time nothing was known about the blessed phrase "increase of productivity". The notion that substantially more could be produced per hour or per individual was perceived by very few people, and Sir Rider Haggard, in particular, would have been completely incredulous at the idea that in forty years the produce per head, or production per hour, could be multiplied three-fold, as Mr. Clark's table showed has in fact been the case in

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the United States. It was this increase in productivity of those of working ages which provided present-day justification for looking to the future—when there will be a still bigger proportion of retired people in the population—with some equanimity. Looking ahead should be an incentive to those of working ages to assist in increasing productivity, since on this alone depended their chances of maintaining their own standard of living after they cease work.

The increase in productivity had had many economic consequences. The growth in cattle stocks in the United States in recent years seemed almost prodigious. Apart from its effect on food supply it had produced a remarkable change in the raw material for the leather industry. The United States, having once been the largest hide importer in the world was on the road to becoming the largest exporter, and the effect of this is reflected throughout the greater part of the world.

Mr. Clark had dealt with the problem of agricultural productivity with great clarity and he (Dr. Snow) hoped that there were young statisticians who would follow Mr. Clark and, in particular, provide a fuller picture of the effect of increased productivity in this generation on the welfare and happiness of the next.

Mr. W. F. Searle said that his chief interest was in Table 5 of the paper. He agreed with Mr. Clark that there was little published information about population and real income trends in underdeveloped territories but quite a large amount of data was becoming available and it was for the people who were doing this work to bring it, as soon as possible, to the stage when publication would be practicable. Quite a number of territories under the Colonial Office could have been included in this paper, had Mr. Clark had access to unpublished material. For example, it would be possible to include data for one or two African territories in Table 2 showing the real products per head engaged in agriculture and fishing. He did not know how the unit problem would be solved but could visualize "African units" which might, in fact, not be very different from Mr. Clark's "O.U.'s." These problems might be overcome in one way or another and something would also have to be done to bring in females employed in agriculture as well as males.

He had found himself considering what he would do on Table 5 if he had to set out figures for the expected percentage increase in aggregate demand for farm products over 25 years in certain low-income countries. The present average rate of population increase in African countries under the wing of the Colonial Office was of the order of 1·5 per cent. per annum. With the development of medical services and so on he expected that this would increase and he believed that over the 25 year period, 1950–75, there would be at least a 50 per cent. increase in the population. He found the best estimate for the next column, the increase in the "Real income per head", a grave difficulty because there was so little to go upon. He would then have made some estimate of the increased demand for farm products over a 25-year period arising from non-agricultural population. Whether he could allow anything for the increase in demand for food from the agricultural population itself in those 25 years was an open question. Combinations of possible figures led to a conclusion that, as compared with the expected increase in aggregate demand for farm products for all low income countries over 25 years being 48 per cent. as set out in the paper, the increase for the territories he was considering would be at least 70 per cent. i.e., at least as high as Mr. Clark's average for all high and medium income countries.

It was not easy to get a clear picture of future supplies of farm products in any of the more advanced areas with which Mr. Clark had dealt, and from the angle of the tropical countries, he could not put forward figures. All that could be done would be to generalise from the judgments of agricultural experts.

Mr. J. L. Nicholson said that it was impossible not to be impressed by the boldness, which was often breath-taking, and the wonderfully broad sweep which were the outstanding features of Mr. Colin Clark's treatment of his material. While the more painstaking and pedestrian statistician would do well to keep several steps behind him, it was Mr. Colin Clark's privilege—in view of his reputation one could almost say it had become his function—to march several steps ahead of all the rest of us. This made it difficult for anyone who was accustomed to painting on a much smaller canvas to comment on a work which resembled Tintoretto's *Paradise*, without appearing to fuss over trifling details. The present paper did, however, raise some general questions about the meaning which could be attached to international comparisons, of the kind that was becoming increasingly popular.

If we were going to compare the agricultural output of different countries, we must clearly adopt some such device as the International Unit. But what did such comparisons really mean? In view of the wide differences in climate, in the needs of the population, in traditions, habits, tastes and even in the economic systems, did it really mean very much to say that the agricultural output per male of Iceland was 10 times that of Italy, and was about the same in Japan and Turkey?

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Mr. Colin Clark admitted the weakness of some of these comparisons by introducing a different unit for comparing some of the oriental countries; but he seemed prepared to overlook the very substantial differences between the countries within each of his two worlds. The International Unit reflected the relative valuations of different commodities which were accepted by producers and consumers in the United States in 1925–34. These were not necessarily—indeed we knew they were not—the same as the relative valuations which producers or consumers would attribute to the same commodities in, say, Finland or Chile in 1952. Even if the relative prices were the same, a bushel of wheat in Chicago was not the same commoditiy as a bushel of wheat in Helsinki, or Santiago; it might represent very different degrees of utility to the same consumer, and *a fortiori* to different consumers, in different parts of the world. Mr. Nicholson would not go so far as to say that all such international comparisons were meaningless. It was a question of degree, some comparisons being more valid than others.

Turning to a detail: it was not clear why the oriental unit was defined as "the quantity of goods exchangeable for an Indian rupee in 1948–49". All it depended on were relative prices and it appeared that the actual prices used were those of 1931–32. Multiplication of all prices by 5, the approximate change in prices between 1931–32 and 1948–49, did not really make any difference.

When Mr. Colin Clark went on to estimate income and price elasticities by comparing the results obtained for different countries, one's doubts were increased, particularly if the estimates were regarded as comparable with elasticities estimated for a single country. A given elasticity, within a country, might be consistent with a different "elasticity"—to give the term a rather more elastic meaning—as between one country and another. One reason why Mr. Colin Clark's income elasticities of demand for food were smaller than those which he (Mr. Nicholson) had obtained in the work to which Mr. Clark referred was, he thought, that countries with a low income per head probably had larger families, on the whole, than countries with a high income per head. His own estimates were based on figures relating to families of a given size.

Mr. Clark attempted to derive price elasticities by comparing the variations in the consumption of different countries that were not explained by income with relative prices. The results which were given in Diagram II showed, he said, that the price elasticity must be between 0·42 and 0·67. But the diagram suggested that there was almost no correlation; at any rate, the lower limit of the estimated price elasticity must be much less than 0·4. It was not surprising that the correlation was so small, when there were so many other factors which could account for differences between the estimates for different countries. It was also rather doubtful whether an estimate of price elasticity between countries could be used as a valid measure of price elasticity within countries.

Professor LEWIS said that he would join with those who had asked for statistics of productivity per acre, and in particular would plead for such statistics to be included in the next edition of *The Conditions of Economic Progress*. He was more interested in the performance of land than of men and machines since land was more likely to be in short supply than men or machines. If the world became short of food it would find all the labour or machinery needed for increasing supplies, but could it find the land? His own view was that the likelihood of food shortage was both overestimated by some for the long period, and underestimated by others for the short period, but before we could form a judgment on these issues we needed to know more about available land and about potential productivity.

Similarly he doubted whether it was safe to base the conclusion that the United States must become an ever larger net importer of food simply on statistics of past trends in the United States. When the United States first became a net importer of food, just before the first world war, Latin America, Oceania and Eastern Europe were large exporters, and Asia and Africa were self-sufficient. These conditions had changed drastically, with the result that the rest of the world again depended on the United States for food, and we could not estimate whether this dependence would increase or diminish unless we estimated supply and demand for the world as a whole.

Mr. COLIN CLARK, in reply, said that fortunately the questions of Professor Stamp, Mr. Searle and Professor Lewis could be answered in one reply. They related to the productivity of land, or the amount of land required to support one person. He thought they might very well consider the Dutch standard in this respect. It was true that land was a little more fertile in the Netherlands than in most other countries—it had been heavily fertilized for generations. But there the area required for the support of one person was a little under one acre, and the Netherlands was an exporter of farm products. The average area per man at work in agriculture was about 16 acres. No western country was so densely settled as that. At the same time they arranged to produce in the Netherlands a very satisfactory diet. As for the tropics, Mr. Searle would remember the Colonial Office publication *Economics of Agriculture in a Savannah Village* by Miss Haswell, in

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

which it was shown that, when only hand tools were used, the maximum cultivable by an able-bodied man was 8 acres: that was in a fairly dry climate. In rainy areas in the tropics, in banana-growing country, it had been shown that the actual cultivated area *per family* was not more than 2½ acres. This form of agriculture used no fertilizers, except to rotate cultivation on scrub-land; with heavy expenditure on fertilizers an acre of tropical land could produce more than enough to feed a Dutchman.

Myxomatosis in rabbits had had an economic effect in Australia greater than anybody had expected; wool and mutton yields had greatly improved.

Mr. Campion had raised the question of the low income countries. It was quite true that the hyperbolae in the paper were affected by the income distribution in different countries. If the individual consumption function is convex, the national average will always lie *below* the curve; the further below, the more unequal the income distribution. It was for this reason that South Africa had been omitted. He desired to add that although he had given no figures for silk as an agricultural product he had included it among the figures of production measured in Oriental Units.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Marcus Falk Alexander.
Jack Balmforth.
Malcolm Harris.
Harold Hornby.
Henry Humphrays.
Thomas William Kelly.
Eric Jones.
Peter Loftus.
John Major Munden.
Eleanor Marjorie Owen.
Harry Wilfred Wallace Pollitt.
Max Richardson.
Geoffrey Wilfred Stokes.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Outlines of the Road Goods Transport Industry

By K. F. Glover and D. N. Miller

[Read before the Royal Statistical Society, April 28th, 1954,
Professor A. Bradford Hill, C.B.E., F.R.S., Ex-President, in the Chair]

Introduction

While a considerable amount of information had been available for many years about the railways and the work which they do, little or nothing was known about the carriage of goods by road. There were no comprehensive statistics of the volume of traffic carried, either measured in tons or ton miles, or of the mileage run by road goods vehicles. There were no figures on which ideas of the length of haul for various sorts of vehicle could be based. Nothing was known in specific terms about the numbers of vehicles engaged in carrying different kinds of goods.

Some statistics have been available for the last few years about the tonnages carried, the vehicle miles run and the fuel consumed by the vehicles of the Road Haulage Executive but these covered only a comparatively small part of all road goods transport.

Certain statistics have been available for some time about the vehicles themselves as distinct from the work that they do. These were derived from two different sources. In the first place there were the figures derived from the procedures for registering and licensing, now regulated by the Vehicles (Excise) Act 1949. These include analyses of vehicles newly registered, quarterly figures of those with current licences and an annual classification by unladen weight and type of fuel of all goods vehicles with excise licences current at any time in the September quarter of the year. There is, however, no analysis from this source by type of carriers' licence or ownership (whether belonging to the British Transport Commission or not). Secondly, there are the statistics derived from the operation of the Road and Rail Traffic Act of 1933. These give analyses by type of carriers' licence as well as by unladen weight, and are available for the ends of each quarter. These figures, however, give no analysis by type of fuel.

The British Transport Commission publishes information about the goods vehicles under its control, but it would not have been possible to fit these into a general picture based on the excise and carriers' licence figures, which analyse vehicles by unladen weight as the Commission analyses its vehicles by carrying capacity.

These statistics about the goods vehicles of the country gave little or no indication of the use which was made of them. In order to get some information to fill, or at least to narrow, this gap in our knowledge of the British economy it was decided to conduct an enquiry on a sample basis.

The Sample Enquiry

I. Organization

A certain amount of background information of considerable value in planning the enquiry was available from a somewhat similar enquiry conducted for one week in March, 1948, in connection with fuel rationing. This gave some pointers to the desirable stratifications and to the orders of magnitude of some of the dispersions which would be encountered. It also showed the difficulties which operators would experience if any very detailed questions were asked or unfamiliar information requested. While those questions which dealt with the vehicle appeared to have given operators little difficulty it was a different matter when it came to the work performed. A large proportion of the operators do not appear to be able readily to give the kind of information that is required for statistical purposes, and it was therefore necessary to ask for the minimum amount of data. The latter had to be of such a nature that further calculations could be made of the statistics of which estimates were wanted, such as tonnage carried and ton mileage run. The experience of the previous enquiry also demonstrated the administrative and clerical difficulties which would be encountered if anything more than the minimum size of sample were attempted.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The task of selection of operators, despatch of forms and "chasing" had to be undertaken by already hard pressed staff in the Ministry of Transport offices. The forms themselves were completed in a variety of ways and so required individual scrutiny and checking, which proved a laborious and lengthy business. It was decided that a sample covering about seven to eight thousand vehicles was the largest that could reasonably be contemplated.

It also appeared that one week was the longest period for which it would be advisable to ask operators to maintain records of a nature which they did not normally keep. There was therefore the difficulty of choosing a week which would not be too seriously disturbed by seasonal influences. For the enquiry which is to be the subject of this paper a week in September, 1952, was chosen, from 22nd to 28th, as coming after the disturbing influences of summer holidays had ended and before the autumn boom in output really began.

The vehicle fleet which it was proposed to sample is summarised in Table 1, which was derived from the carriers' licence statistics and other sources.

TABLE 1

Goods Vehicles(1) *at* 30 *September*, 1952

(*Number*)

Unladen Weight: Over	Not Over	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	Total	*British Transport*(2) *Commission* — *Road Haulage Executive*	*Railway Executive*	Total	Total
	12 cwts.	67	50	380	85,125	85,622	80	40	120	85,740
12 cwts.	1 ton	573	300	2,286	269,161	272,320	820	400	1,220	273,540
1 ton	2 tons	3,460	764	8,926	201,344	214,494	1,620	2,880	4,500	218,990
2 tons	2½ ,,	11,685	3,163	21,674	124,196	160,718	6,700	6,050	12,750	173,470
2½ ,,	3 ,,	16,309	5,456	23,658	94,656	140,079	13,300	3,040	16,340	156,420
3 ,,	5 ,,	6,848	2,661	5,401	40,122	55,032	9,900	2,090	11,990	67,020
5 ,,		1,438	611	509	11,994	14,552	6,880	150	7,030	21,580
Total		40,380	13,005	62,834	826,598	942,817	39,300	14,650	53,950	996,770

(1) Including petroleum tankers but excluding vehicles licensed by farmers at special rates.
(2) Distribution by unladen weights estimated.

Symbols used in tables: .. = Not available. — = Nil or insignificant.

It may be helpful to give a few words of explanation about the several types of carriers' licences. A more extended note will be found in Appendix II. The following remarks described the situation at the time of the sample, before the Transport Act, 1953, came into operation. "A" licence vehicles may only be used for the carriage of goods for hire or reward. Contract "A" licence vehicles may only be used under a contract made for the carriage of another person's goods. "B" licence vehicles may be used for the carriage of goods for or in connection with the holder's own business and, subject to restrictions, for the carriage of goods for hire or reward. "C" licence vehicles may only be used for the carriage of goods for or in connection with the holder's own business. British Transport Commission vehicles do not require carriers' licences.

It will be appreciated that under the Transport Act 1947 vehicles with "A", Contract "A" and "B" licences are subject to limitations on their operations, being confined to journeys within a twenty-five miles radius of their operating base. This does not apply, however, to vehicles engaged in carrying certain traffics, such as liquids in bulk, furniture, meat and livestock, or indivisible loads. Moreover the British Transport Commission may grant permits to operators to undertake work outside the twenty-five mile limit.

All figures of the weight of goods vehicles refer to unladen weight unless otherwise stated. Throughout the paper vehicles are classified in weight groups of over a certain unladen weight and not over another, e.g., "Over 2 tons, u.w. not over 2½ tons", but this is sometimes abbreviated to "2–2½ tons".

It was not possible to give proper coverage to petroleum tankers. These are consequently

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

omitted from all the tables except Tables 1, 22 and 23. Through the courtesy of Mr. C. T. Brunner of Shell Mex and B.P. Ltd. it was possible to include estimates of the road movement of petroleum products in Tables 22 and 23.

The basic stratification used has been that of Table 1. It was clear that the legal conditions attached to carriers' licences and the nature of the work to be performed by the Road Haulage Executive's vehicles and those of the Railway Executive would make a stratification under these six headings desirable. It was obvious also that a considerable stratification by size was desirable. It was finally decided to choose seven unladen weight groups, as set out in Table 1. The only point which calls for comment is the choice of $2\frac{1}{2}$ tons as one of the dividing points. It was felt that this was desirable on several grounds. The speed limit for heavy goods vehicles previously covered vehicles of over $2\frac{1}{2}$ tons unladen weight and this might have left some traces on the employment of fleets. Secondly, since the lower limit was raised from $2\frac{1}{2}$ to 3 tons unladen weight the number of vehicles, in the $2\frac{1}{2}$–3 ton group, particularly those operated under "C" licences has increased markedly and it was felt that it would be interesting to see something of the nature of their work. Thirdly, in weight groups of over 2 tons the carrying capacity of vehicles begins to diverge very sharply from their unladen weight and it appeared desirable to have as narrow a subdivision at this point as possible. The differences which have emerged between the 2–$2\frac{1}{2}$ and the $2\frac{1}{2}$–3 tons groups have been considerable, and in our opinion justify this feature of the stratification.

The total number of vehicles which it was possible to cover, namely about seven to eight thousand, determined the overall sampling fraction. There was, however, no reason for maintaining a constant sampling fraction, as the previous enquiry had shown that the dispersions varied from one cell to another. The tonnage and ton mileage dispersions were not known with any accuracy, and vehicle mileage was selected as being a statistic of major significance, not only in itself but because the estimates of ton mileage would depend partly upon it. The total number of vehicles to be sampled was therefore divided up between the cells with an eye to rendering the standard errors of the mean vehicle mileage in each cell about the same.

The "frame" used in taking the sample consisted of the vehicle index in which there is one sheet for every vehicle operated under a carriers' licence or by the British Transport Commission. Those under carriers' licence are sorted in alphabetical order of the operator's name. The index is in sections, each of the Licensing Authorities for Goods Vehicles having the sheets relating to vehicles licensed in his Area in his office. An instructional table was made out for each section of the index showing how many vehicles of each carriers' licence and unladen weight group were to be selected. The numbers of vehicles to be selected in each cell were proportionate to the numbers of vehicles of that category licensed in that Area. That is to say, although the sampling fractions varied between cells, for a given cell they were constant between Areas. Those in charge of the several sections of the index were then asked to begin at the first box in which the sheets were packed and select each twentieth sheet. The registration letters and number and the licence/unladen weight group of the vehicle was recorded, and a note made of the name and address of the operator. Then the fortieth sheet was similarly selected, and so on until the requisite numbers of vehicles had been selected for each cell.

A form was sent to the operators of the vehicles chosen, asking them to state the unladen weight and carrying capacity of the vehicle, the type of carriers' licence, the type of fuel used and the year of manufacture. Operators were also asked to state the mileage run loaded over 50 per cent. of weight capacity, loaded under 50 per cent. of weight capacity and empty, specifying each journey separately, the nature of the goods carried and the maximum load carried at any point on each journey.

The legal powers used were those conferred on the Minister of Transport by the Statistics of Trade Act, 1947.

II. Results

In all 7,243 forms were returned and used as shown in Table 2. The number returned represented a total response rate of slightly over 90 per cent. Many of the forms which were not returned were in respect of vehicles which the operator had sold or whose operator has gone out of business: there is no reason to suppose, therefore, that their omission from the sample will impart a bias. In all the circumstances this was felt to be a satisfactory response. However, not all

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Forms Returned and Used

(*Number*)

Unladen Weight: Over	Not Over	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	*British Transport Commission* Road Haulage Executive	Railway Executive
	12 cwts.	—	—	—	312	—	—
12 cwts.	1 ton	—	—	226	410	—	—
1 ton	2 tons	250	—	283	408	—	111
2 tons	2½ ,,	337	282	372	380	116	136
2½ ,,	3 ,,	291	268	231	370	273	136
3 ,,	5 ,,	215	181	291	330	198	127
5 ,,		215	—	—	258	236	—
Total		1,308	731	1,403	2,468	823	510
					Grand Total		7,243

the forms could be used for all the purposes of the enquiry; for example, some forms, while giving all the data relating to the vehicle, were vague about the nature of the goods carried or carelessly completed as regards the analysis of mileage run. In the calculations which follow only those forms were used which in the case of the statistic in question appeared to be properly and reliably filled in.

Every effort has therefore been made to secure an adequately large sample, a proper selection of vehicles and a sufficiently large response rate. The necessary designation of the vehicles in advance of the week for which records had to be kept may have tended to bias certain of the answers, but it is unlikely that errors from this source are large enough to upset seriously the conclusions arrived at. The figures which follow must be regarded as the best estimates which could be obtained in the circumstances. It is not claimed that all the statistics are consistently accurate. Some of the conclusions must be regarded as tentative and subject to review if another investigation comes to be made in the future.

Section A.—Summary

1. Many of the findings of the sample survey consist of detailed information about the nature and the quantity of work being done by particular sizes and categories of vehicle. These data are set out in the various tables.

2. The legal and administrative distinctions between vehicles—the several kinds of carriers' licence and the two Executives of the B.T.C.—correspond to genuine and substantial differences in the nature and quantity of work performed by each vehicle. It is naturally not possible to say from a survey of this kind whether the legal distinctions were a cause of these or whether the differences existed first. In other words it is not possible to estimate the extent to which the institutional framework encourages or discourages the utilisation of the capital equipment.

3. The nature and characteristics of the work performed by a vehicle (piecemeal deliveries or carriage of single loads, long hauls or short, etc.) play a major part in determining the operating statistics, such as the weekly mileage and ton mileage.

4. The aggregate work performed by road goods transport probably amounts to about nineteen thousand million net ton miles in a year, and about nine hundred million tons are carried. Road goods transport is thus a major part of the country's transport system.

5. A substantial volume of this traffic is on quite long hauls. Probably about ninety-five million tons a year are carried on hauls of over forty miles.

6. "C" licence operation, that is carriage on own account, is of preponderant importance. It accounts for 54 per cent. of total ton mileage, 60 per cent. of total tonnage. Half the traffic carried on hauls of more than 40 miles is carried in "C" licence vehicles.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Section B.—The Vehicles

1. *Carrying Capacity*

TABLE 3

Mean Carrying Capacity

(*Cwts.*)

Unladen Weight						*British Transport Commission*	
Over	*Not Over*	*"A" Licence*	*Contract "A" Licence*	*"B" Licence*	*"C" Licence*	*Road Haulage Executive*	*Railway Executive*
	12 cwts.	..	..	..	6	..	..
12 cwts.	1 ton	..	..	11	10	..	..
1 ton	2 tons	40	..	39	26	..	41
2 tons	2½ ,,	81	89	76	63	91	55
2½ ,,	3 ,,	104	109	104	95	113	73
3 ,,	5 ,,	141	139	125	125	154	133
Over 5 tons		235	..	..	199	257	..

Table 3 gives the mean carrying capacity in hundredweights of the vehicles in the basic classification. Two major points emerge. First there is the rapid increase in the ratio of carrying capacity to unladen weight with the size of the vehicle. Secondly, Road Haulage Executive, "A" and Contract "A" licence vehicles tend to have a higher ratio of capacity to unladen weight than "C" vehicles. This may be partly due to a greater degree of specialization in the body work of the ancillary vehicles but is likely to be often attributable to a tendency to use vehicles of different types. This sort of specialization shows up clearly in the case of the Railway Executive where the lower average ratio of carrying capacity to unladen weight is due to the use of a substantial proportion of mechanical horses and trailers. In the third place in the heavier groups there is a greater tendency on the part of "C" vehicles to be concentrated towards the lower end of the range of unladen weights in each cell, which is reflected in the average for the cell.

2. *Type of Fuel Used*

TABLE 4

Proportions of Vehicles in Sample Using Diesel Fuel

(*Per cent.*)

	Unladen Weight				
	2–2½ Tons	*2½–3 Tons*	*3–5 Tons*	*Over 5 Tons*	*Total*(1)(2)
"A" licence	1	11	36	88	14
Contract "A" licence	0	7	32	..	13
"B" licence	1	7	26	..	6
"C" licence	1	8	30	79	4
British Transport Commission					
Road Haulage Executive	6	30	63	96	43
Railway Executive	0	0	6	..	1
Total(1)	1	10	39	85	6

(1) These totals have been calculated by weighting each proportion by the numbers of vehicles in the total vehicle fleet (see Table 1). Hence these totals represent estimates for the country as a whole.

(2) This column applies to vehicles of all sizes and not only those shown in the table. Smaller sizes run almost entirely on petrol.

Steam and electrically propelled vehicles have been excluded from the sample owing to their relative insignificance. In the 1952 census of mechanically propelled road vehicles less than 2 per cent. of goods vehicles were electrically propelled and only one hundred steam vehicles remained on the roads.

The pattern which emerges from Table 4 is a familiar one, namely that the larger vehicles are

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

more often diesel-engined, but it is interesting to note the extent to which this applies to "C" licence vehicles as well as to those engaged in public haulage. Few diesel vehicles appear to be employed in the sort of work done by the Railway Executive's road vehicles.

3. *Age of Vehicles*

It was felt that the most convenient manner of presenting the information about the year of manufacture of the vehicles in the sample was by giving, for each cell of the basic stratification, the percentage falling into certain periods. It will be appreciated that in view of the numbers involved these proportions may be subject to considerable sampling errors. The data are set out in Table 5.

The mean mileages per week of vehicles of the three age groups were examined for certain cells. The figures applied to vehicles which were actually running during the week. It was found that in the case of "C" licence vehicles there were significant differences between the different ages, the older vehicles running fewer miles, but this was not so for Road Haulage Executive and "A" licence vehicles. One explanation may be that in "C" fleets vehicles have found their way into those types of work for which their age suits them: for example an operator who only runs his vehicle for a comparatively small number of miles in a week may tend to buy a rather elderly used vehicle while an operator who intends to run his lorry for a large number of miles will wish to have a new one that will not involve heavy maintenance expenditure. A public haulier, on the other hand, may tend towards "common user" of the vehicles of his fleet, aiming at a common standard of maintenance and employing his vehicles interchangeably.

TABLE 5

Age of Vehicles

Proportions Manufactured in Certain Periods

(*Per cent.*)

Unladen Weight		*Year of Manufacture*	*"A" Licence*	*Contract "A" Licence*	*"B" Licence*	*"C" Licence*	*British Transport Commission*	
Over	*Not Over*						*Road Haulage Executive*	*Railway Executive*
	12 cwts.	–1939	..	..	..	38	..	..
		1940–1945	..	..	..	3	..	..
		1946–1952	..	..	..	59	..	..
12 cwts.	1 ton	–1939	..	..	30	24	..	..
		1940–1945	..	..	13	11	..	..
		1946–1952	..	..	57	65	..	..
1 ton	2 tons	–1939	62	..	64	34	..	31
		1940–1945	6	..	10	6	..	7
		1946–1952	32	..	26	60	..	62
2 tons	2½ ,,	–1939	31	28	28	22	13	18
		1940–1945	18	20	27	17	16	18
		1946–1952	51	52	45	61	71	64
2½ ,,	3 ,,	–1939	10	10	12	7	6	10
		1940–1945	24	30	29	20	28	10
		1946–1952	66	60	59	73	66	80
3 ,,	5 ,,	–1939	16	9	8	12	13	11
		1940–1945	19	29	23	16	14	19
		1946–1952	65	62	69	72	73	70
5 ,,	—	–1939	25	..	..	16	14	..
		1940–1945	20	..	..	14	24	..
		1946–1952	55	..	..	70	62	..

Ex-Service vehicles were regarded as having been manufactured in the period 1940–1945. Table 5, taken in conjunction with the analysis of the vehicle fleet given in Table 1 suggests that

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

at September, 1952, roughly three-fifths of the goods vehicles on the roads have been manufactured since the war.

In the second place the medium and heavy groups show a high proportion of vehicles built in 1940–1945. This is largely because a large number of ex-Service vehicles were of this size. "C" licence fleets on the whole appear to have a smaller proportion of this sort of vehicle than "A" Contract and "B" operators.

Thirdly the Road Haulage Executive fleet appears to be generally newer than that of "A" licences. This may be the result of much scrapping of old vehicles by the Road Haulage Executive.

The "C" fleet is on the whole new, which of course reflects its rapid post-war growth.

Section C.—Operation of the Vehicles

4. *Idle Time*

It was obvious from the outset of the enquiry that many vehicles would be found which were not at work during part or all of the week covered. Some were idle because of holidays. Nearly all were idle for at least one whole day, usually but not always, Sunday. Many were not working on Saturday afternoon, though others took a half day at other times in the week. Some, of course, did not work at all on Saturday. It was therefore extremely difficult to tell whether the absence of work on a particular day was due to the holiday of the crew or to absence of work for the vehicle to do.

A separate record was kept of those vehicles which were idle for the whole week. This was essential for making an estimate of the number of vehicles running at any one time, which was necessary for the estimate of the aggregates of Tables 20, 21, 22, and 23. Vehicles which did not run at all during the week were excluded from the calculations of the mean mileage, ton mileage, tonnages carried, etc., and, of course, from the tables of the nature of commodities carried.

TABLE 6

Mean Number of Whole Days Spent Idle in the Week for All Reasons

(*Number*)

Unladen Weight		"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	*British Transport Commission*	
Over	*Not Over*					*Road Haulage Executive*	*Railway Executive*
	12 cwts.	..	..	..	2·03	..	..
12 cwts.	1 ton	..	..	1·90	2·00	..	..
1 ton	2 tons	2·22	..	1·95	2·36	..	1·63
2 tons	2½ ,,	2·00	1·94	1·86	2·13	1·94	1·41
2½ ,,	3 ,,	1·73	2·24	2·21	2·09	1·86	1·26
3 ,,	5 ,,	1·97	2·16	2·00	2·44	1·84	1·57
Over 5 tons		1·92	..	..	2·35	1·94	..

Table 6 gives the mean numbers of whole days spent idle for any reason, and includes seven days in respect of each vehicle in the sample which did not run at all during the week. It therefore includes all whole-day holidays, and all the whole days spent under or awaiting repairs. In an enquiry of this nature it was not felt to be practicable to make the questionnaire of such a nature that periods of less than one day idle would be recorded, but it is felt that the figures of this and succeeding tables make possible minimum estimates of the time various sorts of vehicle spend off the roads, and enable us to draw certain broad conclusions.

Similarly, Table 7 gives the number of whole days spent idle for mechanical reasons, that is under or waiting repair. Vehicles under repair for the whole week were treated as being under repair for six days and idle for other reasons for one day. The figures provide a minimum estimate of the time lost by repairs but understate the true total to an unknown extent.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 7

Mean Number of Whole Days Spent Idle in the Week for Mechanical Defects

(*Number*)

Unladen Weight		"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	*British Transport Commission*	
Over	*Not Over*					*Road Haulage Executive*	*Railway Executive*
	12 cwts.	..	..	..	0·28	..	..
12 cwts.	1 ton	..	..	0·24	0·30	..	..
1 ton	2 tons	0·49	..	0·33	0·51	..	0·54
2 tons	2½ ,,	0·59	0·50	0·45	0·40	0·41	0·30
2½ ,,	3 ,,	0·41	0·64	0·73	0·46	0·33	0·24
3 ,,	5 ,,	0·54	0·65	0·54	0·63	0·36	0·39
Over 5 tons		0·43	..	..	0·45	0·61	..

TABLE 8

Mean Number of Whole Days Idle in the Week according to Age

(*Number*)

	Year of Manufacture	*Days Idle*	
		For Repairs	*For Other Reasons*
"A" licence	–1939	0·66	1·90
	1940–1945	0·74	1·40
	1946–1952	0·30	1·36
Contract "A" licence	–1939	0·55	1·83
	1940–1945	0·77	1·68
	1946–1952	0·50	1·43
"B" licence	–1939	0·64	1·54
	1940–1945	0·74	1·53
	1946–1952	0·37	1·39
"C" licence	–1939	0·59	2·28
	1940–1945	0·56	1·64
	1946–1952	0·35	1·64
British Transport Commission			
Road Haulage Executive	–1939	0·58	1·65
	1940–1945	0·45	1·42
	1946–1952	0·36	1·38
Railway Executive	–1939	0·51	1·28
	1940–1945(1)	..	..
	1946–1952	0·36	1·07

(1) Of the Railway Executive vehicles manufactured in the period 1940–1945 too few were sampled to justify inclusion of estimates.

Table 8 analyses by age of vehicle the time which vehicles of the various licence categories spent under or awaiting repair or idle for other reasons.

The repair figures of Table 8 show significant differences between vehicles of different ages: the newer vehicles are less often off the road for repairs. It was not possible, however, to discover significant differences between vehicles under the several types of carriers' licence or Executive: the sample was too small to establish any differences which may exist in this respect. There are also indications that ex-Service vehicles may be particularly often in need of maintenance work.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The time spent idle for non-mechanical reasons shows signs of a different influence. The older vehicles appear to be employed on less intensive work or to be more often used as spares.

Comparisons between repair time and time idle for other reasons may be misleading as the latter probably excludes more half-days than the former, and as was mentioned above a vehicle under or awaiting repair for the whole period of this enquiry was treated as being under repair for six days and idle for other reasons for one day.

5. *Commodities Carried*

It was possible to classify most of the vehicles according to a short list of the commodities which they were wholly or mainly engaged in carrying during the week.

TABLE 9

Proportions of Vehicles Engaged Wholly or Mainly in Carrying Certain Commodities

(*Summary*)

(*Per cent.*)

	Food etc.(1)	*Coal and Coke*	*Building etc. Materials*	*Furniture*	*Iron, Steel and Machinery*	*Remainder* (2)	*Total*
Under 12 *cwt. unladen weight*							
"C" licence	44	1	13	1	1	40	100
12 *cwts.*–1 *ton unladen weight*							
"B" licence	48	1	6	4	1	40	100
"C" ,,	36	1	11	3	1	48	100
1–2 *tons unladen weight*							
"A" licence	16	6	10	10	2	56	100
"B" ,,	14	31	9	10	2	34	100
"C" ,,	38	4	17	2	1	38	100
2–2½ *tons unladen weight*							
"A" licence	16	5	19	13	2	45	100
Contract "A" ,,	12	16	32	4	2	34	100
"B" ,,	14	26	21	10	3	26	100
"C" ,,	30	13	20	3	3	31	100
Road Haulage Executive	18	—	7	4	4	67	100
2½–3 *tons unladen weight*							
"A" licence	16	6	16	13	3	47	100
Contract "A" ,,	12	13	39	1	7	29	100
"B" ,,	10	14	32	10	1	33	100
"C" ,,	24	6	28	4	6	32	100
Road Haulage Executive	15	1	5	2	5	72	100
3–5 *tons unladen weight*							
"A" licence	19	5	12	7	3	53	100
Contract "A" ,,	11	12	45	—	6	27	100
"B" ,,	8	17	32	11	2	30	100
"C" ,,	22	4	26	4	6	38	100
Road Haulage Executive	15	1	7	1	8	68	100
Over 5 *tons unladen weight*							
"A" licence	20	4	18	2	15	41	100
"C" ,,	23	—	27	2	11	37	100
Road Haulage Executive	10	—	5	1	22	62	100

(1) Grocery, confectionery, fish, meat, fruit, vegetables, grain, beet, beer and tobacco.
(2) For further details see Tables 26 to 31 in Appendix I.

Table 9 is a summary of the main features of the more detailed Tables 26 to 31 to be found in the Appendix. A common analysis of goods has been adhered to for each size of vehicle in order to facilitate comparisons although in the Appendix this has given rise to tables in which the number of vehicles carrying certain loads is small leading to large sampling errors. Railway Executive vehicles have been excluded as their loads are predominantly mixed.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It will be seen from Table 9 that small "C" vehicles concentrate on distributing food and groceries. Over one-third are engaged in this kind of work.

Secondly a quarter to one-third of medium weight "B" licence vehicles (1 to 2½ tons unladen weight) are engaged in distributing coal and coke.

In the third place many medium size vehicles with carriers' licences are moving goods in connection with building and constructional work. This includes the cartage of rubble as well as the carriage of various materials. The proportion ranges up to about one-quarter for "B" and "C" licence vehicles and up to about one-third in the case of those under Contract "A" licences. The Road Haulage Executive does not appear to participate very much in this.

Fourthly a substantial number of medium sized "A" and "B" vehicles are carrying furniture. The proportions are of the order of one-eighth of the "A" vehicles and one-tenth of the "B"s.

In the fifth place many of the bigger public haulage vehicles are engaged on carrying iron, steel and machinery. The proportions seem to be between about one-seventh and one-fifth.

Sixthly, Tables 26 to 31 in Appendix I show that vehicles of the Road Haulage Executive have a much greater variety of loads in a week than others engaged in public haulage.

In the seventh place Table 30 in the Appendix suggests that about one-fifth of the "A" vehicles in the 3 to 5 ton unladen weight group are engaged in carrying live animals.

It should be noted that large quantities of any given commodity were carried by vehicles which during the course of the enquiry week carried a variety of goods, and hence were classified under the unallocated group. No estimates can be made of the tonnages of different goods carried.

6. *Vehicle Mileage*

Table 10 gives the mean vehicle mileages of the vehicles in the sample which ran any mileage during the week, and Table 24 in Appendix I the percentage margins of error, based on twice the standard errors of the mean. The latter are rather larger than was intended when the sample was first designed, as the dispersions turned out to be greater than had been expected.

TABLE 10

Mean Weekly Vehicle Mileage

(*Miles*)

Unladen Weight		"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	*British Transport Commission*	
Over	*Not Over*					*Road Haulage Executive*	*Railway Executive*
	12 cwts.	..	..	..	144	...	..
12 cwts.	1 ton	..	..	173	186	..	..
1 ton	2 tons	240	..	162	193	..	117
2 tons	2½ ,,	290	327	246	229	387	153
2½ ,,	3 ,,	396	395	364	347	525	125
3 ,,	5 ,,	419	476	409	393	528	150
5 ,,		493	..	..	464	677	..

Several features appear from these tables.

The small vehicles run comparatively small weekly mileages. In the case of "B" and "C" licence vehicles these average between about 150 and 200 miles. The 2 to 2½ tons group begins to show signs of a different kind of work involving higher weekly mileages.

Vehicles of over 2½ tons unladen weight show marked increases in weekly mileage, except in the case of Contract "A" licence vehicles whose work appears to give high weekly mileages in the 2 to 2½ tons unladen weight group.

In present circumstances there are not very big differences between the weekly mileages of the larger "A" and "C" licence vehicles, but those under "A" licences show higher mileages in the smaller sizes, while Road Haulage Executive vehicles show high weekly mileages throughout.

In so far as diesel-engined vehicles tend to be engaged on work which involves running many miles per week, cells with a high proportion of these vehicles generally have high mean weekly mileages, as can be seen from a comparison of Tables 4 and 10.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The work of "B" licence vehicles did not lead to very different weekly mileages from those of "C" vehicles, although a sample based on one week cannot do anything to show, for instance, the extent to which "B" vehicles can be kept more fully occupied at certain times of the year as a result of their greater freedom.

The Railway Executive vehicles are on the whole engaged in a particular kind of work which places them in a class apart and show fairly consistent figures. They are therefore excluded from the comments. The figure for $2\frac{1}{2}$ to 3 tons unladen weight vehicles was affected by certain vehicles not engaged in the usual cartage work, although other factors may also have been at work.

TABLE 11

Vehicle Mileage Loaded and Empty

(Per cent.)

Unladen Weight			*Contract*				*British Transport Commission*	
Over	*Not Over*		*"A" Licence*	*"A" Licence*	*"B" Licence*	*"C" Licence*	*Road Haulage Executive*	*Railway Executive*
	12 cwts.	Loaded over 50 per cent.	..	..	..	31	..	..
		Loaded under 50 per cent.	..	..	..	48	..	..
		Empty	..	..	..	21	..	..
12 cwts.	1 ton	Loaded over 50 per cent.	..	..	40	30	..	..
		Loaded under 50 per cent.	..	..	40	51	..	..
		Empty	..	..	20	19	..	..
1 ton	2 tons	Loaded over 50 per cent.	48	..	41	34	..	38
		Loaded under 50 per cent.	30	..	28	44	..	46
		Empty	22	..	31	22	..	16
2 ,,	$2\frac{1}{2}$,,	Loaded over 50 per cent.	49	50	45	46	56	35
		Loaded under 50 per cent.	21	14	19	30	22	47
		Empty	30	36	36	24	22	18
$2\frac{1}{2}$,,	3 ,,	Loaded over 50 per cent.	53	50	51	47	69	29
		Loaded under 50 per cent.	15	9	10	24	12	46
		Empty	32	41	39	29	19	25
3 ,,	5 ,,	Loaded over 50 per cent.	54	51	50	51	71	27
		Loaded under 50 per cent.	8	5	7	17	8	40
		Empty	38	44	43	32	21	33
5 ,,		Loaded over 50 per cent.	56	..	..	57	77	..
		Loaded under 50 per cent.	4	..	..	11	6	..
		Empty	40	..	..	32	17	..

Table 11 was compiled by aggregating the vehicle mileages from the forms, split between those run while the vehicle was loaded over 50 per cent. of weight capacity, loaded to 50 per cent. or less of weight capacity, and empty. It must be emphasized that the figures are in respect of weight capacity. This means that if light but bulky loads are carried a vehicle may never be loaded to full capacity in this sense, although no more can be put on it. This approach was essential for obtaining the data for calculating ton mileages but it does mean that vehicles engaged in trades in which, in shipping terms, they are often "full" before they are "down" will show a high proportion of miles run loaded under 50 per cent. of load capacity. For example, the collection and delivery of small consignments and packages may be expected to give this kind of result and may account for the figures in respect of the Railway Executive.

The smaller vehicles generally have a load of some kind for up to four-fifths of their total mileage but often it amounts to less than half their weight capacity. This is the sort of pattern one would expect in the case of vehicles doing collection and delivery work, which necessarily involves the piecemeal dispersal of the load, as opposed to work in which a whole load is picked up at one single point and is set down at another. The larger vehicles, however, show a tendency

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to be either fairly fully loaded or empty; a comparatively small proportion of miles is run loaded under 50 per cent. of load capacity.

This may be partly a result of the fact that the heavier vehicles are more often used for carrying the kind of goods which give a full load in terms of weight: for example whereas finished goods delivered by van are usually bulky in proportion to their weight, the materials carried in the large vehicles make it more often possible to carry a full load in terms of weight.

This tendency of the larger vehicles to be either fairly fully loaded or empty is also attributable to a greater proportion of trips in which a single load is picked up at one end of the journey and set down at the other, a subject discussed further in Section 11 below. In the case of Road Haulage Executive lorries this kind of work clearly predominates. Moreover the high figures of mileage run loaded to over 50 per cent. of weight capacity shown by Road Haulage Execcutive vehicles may be partly due to their obtaining backloads or loads on further "legs" of journeys.

The "C" licence figures for the larger vehicles do not appear to be substantially different from those of "A" operators as regards the proportion loaded over 50 per cent. but they may have a part load rather more often.

7. *Ton Mileage*

The ton mileages of Table 12 were obtained by calculation from the data contained on the forms submitted by operators. Separate calculations were made for each journey or day's work. In the case of journeys which obviously consisted of carrying a single load to a single destination the tonnage carried was multiplied by the loaded mileage. In the case of trips which were in the nature of collection and delivery work, a convention was adopted. The mileage run loaded over 50 per cent. of weight capacity was multiplied by a tonnage midway between the maximum load at any point of the journey and half the vehicle's carrying capacity. The mileage run loaded under 50 per cent. of weight capacity was multiplied by one-quarter of the carrying capacity. This method assumes a steady rate of delivery or collection throughout the journey. In theory it may lead to a downward bias in the figure of ton mileage which it gives, partly because it was not always possible to make allowances for returned empties, etc., picked up on a delivery trip, and partly because vehicles often travel fully loaded for a considerable distance before commencing delivery. The latter consideration, however, will tend to be offset by a long journey home very lightly loaded. In any case the method may help to correct any exaggeration on the part of operators performing this kind of work in estimating the weight of their loads, necessarily much more difficult when the load consists of a number of packages or consignments. The proportion of collection and delivery work diminishes as the size of the vehicle increases so that this formula becomes of less and less importance for the larger vehicles.

The sample did not attempt to obtain all the information required for the calculation of ton mileage in the case of vehicles of not over 1 ton unladen weight. Previous experience had shown that operators of these vehicles had particularly serious difficulty in supplying the necessary information, and the ton mileage which the vehicles perform is by comparison small. For the vehicles of the lower weight groups the ton mile loses its significance as a unit of work done.

The ton mileage performed by articulated units was included in the calculations of the means of Table 12 but the ton mileage of draw-bar trailers was excluded as the latter are not included in the unladen weight of the vehicle.

TABLE 12

Mean Weekly Ton Mileage

(Ton miles)

Unladen Weight						*British Transport Commission*	
Over	*Not over*	*"A" Licence*	*Contract "A" Licence*	*"B" Licence*	*"C" Licence*	*Road Haulage Executive*	*Railway Executive*
1 ton	2 tons	181	..	113	82	..	74
2 tons	2½ ,,	532	823	431	334	1,055	143
2½ ,,	3 ,,	969	1,190	975	784	1,982	137
3 ,,	5 ,,	1,369	1,815	1,231	1,323	2,639	270
5 ,,		3,070	..	..	2,647	5,945	..

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It will be seen from Table 25 in Appendix I that the margins of error in Table 12 are substantial, and only broad inferences can be drawn. It may perhaps be noted here that in order to arrive at estimates of ton mileage within ± 5 per cent., after allowing for all factors, it would have been necessary to have a sample of 45,000 vehicles.

The major feature of Table 12 is the enormous increase in ton mileage per vehicle per week as the size of the vehicle increases. Among "C" licence vehicles, one of over 5 tons unladen weight averages well over three times the weekly ton mileage of one of 2½ to 3 tons and 32 times that of a 1–2 ton vehicle.

Road Haulage Executive lorries of over 5 tons unladen weight have an average carrying capacity of 257 cwts. British Railways railway freight vehicles have an average carrying capacity of 267 cwts. according to the statistics published by the British Transport Commission in its Annual Report, so that there would appear to be little substantial difference between the average carrying capacities. The published statistics suggest however that the railway freight vehicles only perform about 400 ton miles of work a week compared with the 6,000 of the Road Haulage Executive's large lorries.

The averages may not be strictly comparable as the railway wagons may to a certain extent have the additional function of storage containers cushioning irregular traffic demands. Nevertheless the fifteen-fold difference is surprising.

The big dispersion in the Road Haulage Executive 2–2½ tons group is largely accounted for by the overlap between two different kinds of work performed by these vehicles. Some are running short distances on local services, in which they only aggregate comparatively small weekly ton mileages, while others carry loads over long distances. The resulting dispersion in this cell is a symptom of the existence of these two very different types of operation.

The Railway Executive road vehicles again emerge as engaged in a specialized kind of work which does not lead to high weekly ton mileages.

The fourth point that emerges is that in a given unladen weight group the Road Haulage Executive vehicles are in a position to perform most work. Contract "A" vehicles appear to do more work measured in ton miles than "A" licence vehicles, and "B"s generally more than "C"s. As with the vehicle mileage of Table 10 the nature of the work of those who carry for hire or reward enables them to use their vehicles more intensively. This should not be taken as having any bearing whatever on the "efficiency" of the various types of operation.

It would be misleading to make comparisons which implied that the "ton mile" is a homogeneous unit and that the problem is merely one of getting the maximum number of "ton miles" from vehicles. One of the principal features of road goods transport is the great variety of the work done, and this variety appears to be the determining factor in the operating statistics (see especially below, Section 11). Any attempt to make comparisons of efficiency purely on a "pence per ton mile" basis is liable to be misleading.

8. *Tonnages Carried, Average Lengths of Haul and Loaded Journeys*

The figures of tonnages given in Table 13 were calculated from information given by operators on the forms. This was the most difficult statistic to estimate, however. One reason was that the operators had not always set out each journey clearly. Nor did they always give full information about the tonnages carried on each journey. Each form was carefully scrutinized and any internal evidence was made use of in order to arrive at the best possible estimate, but it is nevertheless possible that there is a considerable error of observation in addition to the statistical margin of error which generally varied between about 10 per cent. and 15 per cent.

As with the ton mileage calculations, the tonnages carried by draw-bar trailers have been excluded from the calculations of the means of Table 13.

Table 14 was obtained from the tonnages of Tables 13 and the ton mileages of Table 12. In each cell the lower limit of the span of the length of haul was calculated by dividing the mean ton mileage minus one standard error of its mean by the mean tonnage plus one standard error of its mean; i.e., $\frac{\text{mean} - \text{s.e. of mean of ton mileage}}{\text{mean} + \text{s.e. of mean of tonnage}}$. Similarly, the upper limit was arrived at by dividing the mean ton mileage plus the standard error of its mean by the mean tonnage minus the standard error of its mean.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It was felt that this would give a rough indication of the range within which the average haul for the cell probably lies. It will be appreciated, however, that as these estimates have been derived from other statistics they must be regarded with caution.

TABLE 13

Mean Weekly Tonnages Carried

(*Tons*)

Unladen Weight		"*A*" Licence	*Contract* "*A*" Licence	"*B*" Licence	"*C*" Licence	*British Transport Commission*	
Over	*Not over*					*Road Haulage Executive*	*Railway Executive*
1 ton	2 tons	16	..	19	9	..	29
2 tons	2½ ,,	38	66	40	22	31	36
2½ ,,	3 ,,	49	83	70	40	33	48
3 ,,	5 ,,	65	93	87	48	42	82
5 ,,		76	..	..	63	53	..

TABLE 14

Range of Mean Lengths of Haul

(*Miles*)

Unladen Weight		"*A*" Licence	*Contract* "*A*" Licence	"*B*" Licence	"*C*" Licence	*British Transport Commission*	
Over	*Not over*					*Road Haulage Executive*	*Railway Executive*
1 ton	2 tons	10–13	..	5–7	8–11	..	2–3
2 tons	2½ ,,	12–16	11–14	10–12	13–17	28–42	4–5
2½ ,,	3 ,,	17–23	13–16	12–16	18–22	55–68	2½–3
3 ,,	5 ,,	19–24	17–22	13–16	24–30	57–69	3–4
5 ,,		36–45	..	..	37–48	103–121	..

TABLE 15

Proportions of Vehicles in the Sample Running Different Numbers of Loaded Journeys Per Week

(*Per cent.*)

		Number of Loaded Journeys Per Week				
		Not over 6 Journeys	*Not over 9 Journeys*	*Not over 12 Journeys*	*Not over 20 Journeys*	*Total*
"A" licence	2½–3 tons unladen weight	28	58	74	91	100
	3 –5 ,, ,, ,,	29	51	74	91	100
	Over 5 ,, ,, ,,	58	79	91	98	100
"C" licence	2½–3 ,, ,, ,,	42	64	75	91	100
	3 –5 ,, ,, ,,	47	67	78	90	100
	Over 5 ,, ,, ,,	55	73	85	97	100
Road Haulage Executive	2½–3 ,, ,, ,,	60	81	92	98	100
	3 –5 ,, ,, ,,	64	85	93	98	100
	Over 5 ,, ,, ,,	87	97	99	100	100
Railway Executive	2 –2½ ,, ,, ,,	3	8	33	76	100
	2½–3 ,, ,, ,,	3	6	25	64	100
	3 –5 ,, ,, ,,	3	11	19	56	100

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Clearly there are two forces at work in producing the tonnage figures of Table 13. In the first place, there is the obvious influence of the size of the vehicle, the larger vehicles lifting a bigger tonnage on each trip. Secondly, there is the number of trips run in a week. Road Haulage Executive vehicles of over $2\frac{1}{2}$ tons lift smaller tonnages per week than the corresponding "A", "B" or perhaps even "C" licence vehicles. Table 15 suggests the reason for this: a bigger proportion of the Road Haulage Executive vehicles run only a small number of journeys per week, and hence the average "lift" of goods per vehicle per week is smaller. Table 14 shows that this in turn is probably due to longer hauls.

It would appear that this counterbalancing influence of longer hauls is at work in the "heavier" cells within the Road Haulage Executive, "A" and "C" columns, because the tonnages increase with the size of vehicle in smaller proportion than do the ton mileages, and there is a corresponding increase in the average length of haul. Generally speaking, the bigger the vehicle the bigger the proportion running a small number of journeys per week.

In the previous section the ton mileage of the average railway freight vehicle was compared with that of the largest Road Haulage Executive vehicles. A very rough comparison of the tonnages moved by an average vehicle in a period of time might help to give a further idea of the comparative intensity of transport work performed. The average length of haul per ton on the railway for all traffic is about 75 miles. The Road Haulage Executive vehicles which show the nearest average hauls to this are those of 3 to 5 tons (57–69 miles) and over 5 tons (103–121 miles). Although the average carrying capacity of the former group is about 60 per cent. of that of a railway wagon the vehicles of these two groups shift on an average from about forty to about fifty tons per week. An average railway wagon moves about five tons a week.* To put the point another way, a railway wagon will move about 40 per cent. of its carrying capacity in a week while a Road Haulage Executive lorry on hauls of a similar or greater length will move very roughly five times its capacity.

The high tonnage figures for Contract "A" vehicles in Table 13 compared with those for "A" and "C" vehicles may partly reflect the greater proportion of these lorries carrying goods in connection with building and constructional work, and may partly be due to shorter hauls. However, in view of the fact that mileage, ton mileage and tonnages are all higher for Contract "A" than those for corresponding "A" and "C" licence vehicles, and the hauls are not a great deal shorter, it seems that Contract "A" vehicles may be worked harder all round.

A high proportion of Railway Executive vehicles run an exceptionally large number of loaded journeys per week. Contrary to the showing of vehicles engaged in other types of work, the larger vehicles of the Railway Executive do not show longer average lengths of haul than the smaller ones, and in fact appear to operate larger numbers of loaded journeys per week. The high tonnages and short hauls of all Railway Executive vehicles go further to underline the specialized nature of their work.

9. *Lengths of Haul*

The lengths of haul of Table 14 can only be regarded as broad indices, and changes in emphasis rather than any radical alteration in the nature of work performed account for the differences between the values for one cell and the next. Cells are not watertight compartments. Nor are their populations uniform in respect of any particular statistic. In this section we make an attempt to demonstrate this by illustrating the distribution of average lengths of haul per ton shown by vehicles within certain cells. Moreover, when considering the lengths of haul shown by vehicles it is possible to examine in turn the volume of traffic which each carries, and so throw light on the quantities of goods that are transported various distances.

In order to examine the average lengths of haul per traffic ton shown by individual vehicles the sheet for each vehicle was examined, and the ton mileage represented by the week's work was divided by the tonnage carried. This was done for all the vehicles in certain cells, except the small proportion for which the forms had not been satisfactorily completed. The vehicles were then grouped according to their average lengths of haul, and the tonnages and ton mileages for each group were aggregated. The results are set out in Table 16 in the form of cumulative percentages. For example, 50 per cent. of the total tonnage carried by Road Haulage Executive vehicles of 3–5 tons was carried by those whose average haul did not exceed 60 miles.

* In 1952 1·1 million railway freight vehicles carried 285 million tons of revenue-earning traffic.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In each cell there are vehicles for which the average lengths of haul greatly exceed or fall short of those given in Table 14. For example, in the case of the medium and large "C" vehicles the averages for the individual vehicles range from under 10 miles to over 200 miles. In other words, the cell averages of Table 14 were weighted averages which differed from one another because of changes in the weighting not because of complete alterations in work.

TABLE 16

Vehicles Classified by their Average Lengths of Haul and the Work they do

(*Cumulative percentages*)

	Average Length of Haul per Traffic Ton for the Vehicle Not over (miles)						
	10	20	30	40	60	100	200
"A" licence							
Over 2½ tons not over 3 tons u.w.							
Vehicles	21	50	72	80	87	94	99
Ton miles	8	27	47	56	68	82	94
Tons	36	65	82	88	93	97	99
Over 3 tons not over 5 tons u.w.							
Vehicles	23	53	70	81	90	99	100
Ton miles	9	35	52	68	82	98	100
Tons	33	66	80	89	96	100	100
Over 5 tons u.w.							
Vehicles	6	21	41	51	70	92	97
Ton miles	2	9	21	29	49	84	94
Tons	14	33	52	61	78	96	99
"C" licence							
Over 2½ tons not over 3 tons u.w.							
Vehicles	30	57	70	76	85	94	98
Ton miles	12	33	48	57	69	84	96
Tons	38	70	84	89	93	98	100
Over 3 tons not over 5 tons u.w.							
Vehicles	20	44	59	68	77	88	99
Ton miles	7	23	35	44	55	75	95
Tons	23	58	72	80	87	95	99
Over 5 tons u.w.							
Vehicles	12	28	39	47	63	78	96
Ton miles	2	10	18	25	43	64	91
Tons	24	42	56	65	80	91	99
Road Haulage Executive							
Over 2½ tons not over 3 tons u.w.							
Vehicles	7	17	24	31	47	67	91
Ton miles	1	4	6	9	22	43	77
Tons	14	27	34	41	58	77	94
Over 3 tons not over 5 tons u.w.							
Vehicles	6	14	19	24	36	66	93
Ton miles	1	5	7	9	19	48	87
Tons	8	25	31	36	50	75	96
Over 5 tons u.w.							
Vehicles	1	3	7	11	17	38	83
Ton miles	0·1	0·4	2	3	6	21	72
Tons	2	4	9	13	20	43	86

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Secondly, many of the largest sizes of vehicles are engaged in quite short haul work. Up to 45 per cent. of the "C" licence 3–5 ton vehicles and 28 per cent. of those of over 5 tons have average hauls of not over 20 miles.

In the third place the vehicles engaged in long haul traffic accounted for an appreciable proportion of the total work done in certain cells. One-quarter to one-half of the tonnage carried by the largest Road Haulage Executive vehicles was moved by those whose average hauls were over 100 miles. If we take an average haul of 40 miles as an arbitrary dividing line, however, we can see how far the vehicles are engaged in work that is more than purely local.

In Table 17 the work performed by vehicles showing average lengths of haul of over 40 miles is expressed as a percentage of the total work done by the vehicles in that cell. Thus of all the tonnages carried by Road Haulage Executive vehicles of 3–5 tons unladen weight 64 per cent. was carried by vehicles whose average length of haul exceeded 40 miles.

TABLE 17

Proportion of Work Performed by Vehicles with Average Hauls of Over 40 Miles

(*Per cent.*)

	Unladen Weight			
	Over	*Not Over*	*Tonnage*	*Ton Mileage*
Road Haulage Executive	2½ tons	3 tons	59	91
	3 ,,	5 ,,	64	91
	5 ,,		87	97
"A" licence	3 ,,	5 ,,	11	32
	5 ,,		39	71
"C" licence	2½ ,,	3 ,,	11	43
	3 ,,	5 ,,	20	56
	5 ,,		35	75

This table gives an idea of the extent to which certain categories of vehicles were engaged in long haul traffic, and also shows that the vehicles concerned accounted for a much larger proportion of total ton miles than of total tonnage.

In order to estimate the actual quantities of traffic carried various distances it is in theory desirable to construct a frequency distribution of the tonnages classified according to the distance that each ton or consignment was hauled. This was done for certain cells but proved a lengthy and expensive process. It was found that the quantity of goods carried on individual hauls of, say, not over 30 miles, corresponded closely with the quantity of goods carried by vehicles which showed average hauls of not over 30 miles. The vehicles in many cells had already been grouped according to the average hauls which each showed, and the work for each group aggregated in order to arrive at Table 16. It is therefore felt that these data can be used with a fair degree of confidence to arrive at estimates of the total volume of traffic carried over certain distances.

The method can only be safely applied in respect of distances between about 30 and about 70 miles. In the case of the shortest hauls the method of using vehicle averages tended to understate the tonnages actually carried over the shortest distances, presumably because most of the vehicles in the cells examined, namely those of the middle and larger sizes, tended to carry one or two fairly long distance loads which pulled up the average haul for the vehicle. Similarly, the method of using the average hauls per vehicle tends to understate the tonnages carried on the very long hauls, probably because the vehicles making these long trips often do some shorter ones in the week which pulls down the average haul per vehicle.

By applying the percentages of Table 17 to the estimated weekly aggregate tonnage of Table 21 it is possible to arrive at an estimate of the total weekly traffic carried on hauls of over 40 miles. This amounts to about 1,900,000 tons of which over 1,000,000 tons (55 per cent.) is carried in "C" vehicles. We may take then as a rough estimate of the traffic carried annually by road on hauls of over 40 miles a figure of about 95 million tons, over half of which is in "C" vehicles.

The ton mileage involved is considerable. It can be estimated by the same method of applying the percentages of Table 17 to the aggregate weekly ton mileage figures of Table 20. It amounts

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to about 160 millions a week or perhaps 8 thousand millions a year of which half is in respect of "C" vehicles.

10. *Nature of the Work Performed by "C" Licence Vehicles on Long Hauls*

The previous section has suggested that "C" vehicles account for a considerable volume of traffic on hauls of more than 40 miles. Can anything be said in qualitative terms about this work?

In the first place there were several examples of the delivery of branded goods, particularly foods. These were sometimes carried in whole loads to single destinations, but sometimes delivered to a number of different points.

In the second place there were examples of the long distance delivery of specialized machinery and equipment by the makers or suppliers to purchasers. These loads appeared to originate in a central depot or to require installation or assembly by special workmen. Examples were plant and equipment for civil engineering contractors, equipment for the construction of wells, and special types of machinery such as petrol pumps and aircraft equipment.

Thirdly, many of the long haul "C" vehicles are carrying fragile or damageable goods which would appear to require special attention in loading and unloading. Examples are glassware and goods packed in glass containers, fragile instruments and machinery, precast concrete and tiles, women's clothing, gas and oil appliances, television and radio sets.

Fourthly, there were the vehicles carrying goods for which special constructional features were necessary. For example, there were tank lorries for the carriage of milk, certain chemicals, etc., specially low loading vehicles for the carriage of single indivisible loads of a kind that a firm often had to transport, and vehicles adapted to carry such goods as pipes of a particular length and size.

In the fifth place, there were the vehicles which were obviously closely akin to the conveyor belt of assembly line production, carrying partially manufactured components from one factory to another. There were several vehicles in the sample carrying motor car parts and instruments over long distances from the manufacturer's factory to a place of further assembly.

It is not possible in a paper of this kind to enter in detail into a discussion of "C" licence vehicles and the reasons for their use. It is not easy to see what centrally collected statistics could measure the economies or other benefits which may accrue to traders from running their own vehicles. It would appear, however, that "C" licence vehicles are in fact widely used for a variety of purposes on comparatively long hauls.

11. *Two Types of Work*

Perhaps it would be appropriate here to draw a distinction between two fundamentally different kinds of work that road goods vehicles may do. The first consists of picking up a load at one point and dropping the whole of it at another single point. For convenience, we call this "end to end" work.

The second consists of either picking up a single load and setting parts of it down at a number of different points, or of picking up goods at several points and setting the whole load down at one spot, or of picking up and setting down at many points. This multiple pick-up and/or multiple drop work we call "intermediate" work, as it involves loading and/or discharging at intermediate points along the journey. It is not quite the same thing as collection and delivery work since much of this involves delivery of a single load at a single place.

The distinction has a considerable bearing on the figures. A vehicle doing "intermediate" work will show lower figures of ton mileage and vehicle mileage than one engaged on "end to end" work. Taking "C" licence vehicles as an example:

TABLE 18

Effect of Nature of Work

(*Number*)

"C" Licence Unladen Weight		Mean Weekly Vehicle Mileage		Mean Weekly Ton Mileage	
Over	*Not over*	*On "End to End" Work*	*On "Intermediate" Work*	*On "End to End" Work*	*On "Intermediate" Work*
2½ tons	3 tons . .	360	306	941	532
3 ,,	5 ,, . .	455	313	1,341	675

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In each case the difference between the figures for vehicles engaged in "end to end" work and that for vehicles on "intermediate" work is significant. Differences between the average lengths of haul of vehicles engaged in the two different kinds of work were not significant.

Clearly the averages per vehicle for any cell will be affected by the relative numbers performing the two kinds of work. As might be expected the proportion of vehicles engaged in "intermediate" work falls as the size increases: of the "C" licence vehicles nearly 70 per cent. of sampled vehicles in the 1–2 tons group were so classified, nearly 60 per cent. in the 2–2½ tons group, over 40 per cent. in the 2½–3 tons group, about 25 per cent. in the 3–5 tons group and about 12 per cent. of those of over 5 tons unladen weight.

There was a tendency for vehicles engaged in carrying some goods to be more often engaged in one type of work than the other.

TABLE 19

Nature of Work and Some Commodities Carried
Proportion of All Sample Vehicles in Each Cell

(*Per cent.*)

	"C" Licence 2½–3 Tons Unladen Weight		"C" Licence 3–5 Tons Unladen Weight	
	On "End to End" Work	*On "Intermediate" Work*	*On "End to End" Work*	*On "Intermediate" Work*
Food	8	22	15	12
Builders' supplies and timber	25	1	25	2
Furniture	2	4	—	4
Manufactured goods	6	7	9	2
Other traffics	17	8	26	5
Total	58	42	75	25

The figures of Table 19 represent the proportions of the sample vehicles in each cell engaged in particular kinds of work which were carrying the goods mentioned in the first column. Owing to the small numbers it was felt that sampling errors, already very large, would vitiate any finer analysis.

It can be seen from Table 19 that lorries carrying builders' supplies and timber accounted for a far larger proportion of the vehicles engaged in "end to end" carriage than of those in "intermediate" work, but the reverse was the case with those carrying food.

12. *The Nature of Operations of the Several Categories of Vehicles*

The foregoing sections make it possible to be a little more precise about the nature of the operations being performed by different groups of vehicles.

The Railway Executive vehicles are clearly engaged in highly specialized local collection and delivery services giving much shorter hauls than even the smallest "C" licence vehicles for which the calculation of hauls is possible. But the average distance which they carry their goods, by affecting the number of trips (Table 15) and the amount of time spent loading and unloading, will affect all the other operating statistics.

The Road Haulage Executive vehicles on the other hand are engaged in work involving longer hauls. There are many vehicles even in the smaller sizes operating hauls of considerable length, while the traffic carried by the largest lorries has average lengths of haul in the region of that of the railways for general merchandise traffic. The big differences between the 2½–3 ton group and the 2 to 2½ ton group in respect of ton mileages and length of haul, and the smallness of the difference between the former and the 3–5 tons cell is probably due to the operation of the 20 m.p.h. speed limit for heavy vehicles: the 2½–3 tonners are often employed on journeys which their extra speed allows them to complete in a day. Contract "A" and "B" licence vehicles rarely engage in operations involving long hauls, but Contract "A" vehicles seem to be fairly intensively employed.

Those operating under "A" licences, many of which were carrying traffics which exempted them from the 25 mile radius limit under the 1947 Transport Act, show average hauls from about

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

10 to about 40 miles. On the whole the average hauls are not very different from those of "C" licence vehicles. Nevertheless the 1–2 and 2–2½ tons "A" vehicles show a higher tonnage and ton mileage than the corresponding "C"s. This appears to be due partly to a higher ratio of capacity to unladen weight, but mainly to a greater proportion of what in the preceding section has been called "end to end" work. As the proportion of "end to end" work increases (with increases in the size of vehicle) the ton mileages of "C" vehicles approach more nearly to those of the "A"s.

Those "C" vehicles engaged on "end to end" work often show average vehicle mileages and ton mileages as high as those for "A" licence vehicles of corresponding unladen weights, as can be seen from Tables 10, 12 and 18. It is the nature of the work which determines the operating statistics.

13. *Aggregates*

(a) *Weekly Aggregates*

Hitherto the tables have mainly dealt with averages per vehicle. The main purpose of Tables 20 and 21 is to demonstrate the importance of the actual numbers of vehicles in the cells shown in Table 1. In particular the effect of the large numbers of "C" vehicles of 2–2½, 2½–3 and 3–5

TABLE 20

Estimated Weekly Aggregate Ton Mileages by All Vehicles(1)(2)

(*Millions*)

Unladen Weight Over	Not Over	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	*British Transport Commission* Road Haulage Executive	Railway Executive	Total
	1 ton	—	(0·2)	—	(5·6)	—	—	5·7
1 ton	2 tons	0·6		0·9	14·2	(0·2)	0·2	16·3
2 tons	2½ ,,	5·7	2·3	8·4	37·9	5·4	0·8	60·6
2½ ,,	3 ,,	15·0	5·9	21·2	68·1	21·5	0·4	132·0
3 ,,	5 ,,	8·8	4·3	6·1	43·2	21·3	0·5	84·3
5 ,,		4·2	(1·1)	(0·7)	25·3	31·6	—	62·9
Total		34·2	13·8	37·4	194·3	80·0	2·0	361·7

(1) Excluding petroleum tankers.
(2) Figures in brackets are estimates for unsampled cells.

TABLE 21

Estimated Weekly Aggregate Tonnages Carried by All Vehicles(1)(2)

(*Thousands*)

Unladen Weight Over	Not Over	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	*British Transport Commission* Road Haulage Executive	Railway Executive	Total
	1 ton	(4)	(16)	(6)	(880)	(3)	(3)	898
1 ton	2 tons	49		156	1,491	(12)	74	1,797
2 tons	2½ ,,	402	186	776	2,495	156	205	4,220
2½ ,,	3 ,,	754	407	1,508	3,438	353	139	6,599
3 ,,	5 ,,	416	222	431	1,580	340	157	3,146
5 ,,		103	(55)	(36)	59e	283	(12)	1,089
Total		1,729	886	2,913	10,483	1,147	591	17,749

(1) Excluding petroleum tankers.
(2) Figures in brackets are estimates for unsampled cells.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

tons becomes obvious. These vehicles carry over 40 per cent. of the total tonnage and ton mileage transported by road.

In compiling these two tables and Table 22 due allowance has been made for the numbers of vehicles idle during the sample week. Estimates of the work performed by draw-bar trailers have been included. They accounted for less than 1 per cent. of the total ton miles and about 0·25 per cent. of the total tons carried.

(b) *Annual Estimates*

Previous tables have been compiled in respect of the sample week: it may be of interest to attempt to estimate annual aggregates. For this purpose allowance was made for public and other holidays, in addition to the allowances already made in respect of vehicles idle for mechanical and other reasons. The vehicle fleet was taken to be that of 30th September, 1952.

The annual estimates are given in Table 22. When planning the sample care was taken to select a week which was not obviously dominated either by a seasonal peak or a trough, but the substantial seasonal movements in road goods transport may make this kind of estimate of annual totals hazardous.

We think it likely, however, that the various seasonal movements tend to cancel one another out so that the totals are probably not unreliable. Moreover, the aggregates for all vehicles under all types of licence, etc., are more likely to be accurate than the totals for, say, "B" licence vehicles, since seasonal movements do not affect all categories of vehicles to the same extent, or, at any one time of the year, in the same direction.

TABLE 22

Estimated Annual Aggregates

All Goods Vehicles[1]

	Vehicle Miles (Millions)	*Tonnage (Millions)*	*Ton Miles (Thousand Millions)*
"A" licence	671	86	1·7
Contract "A" licence	224	44	0·7
"B" licence	834	146	1·9
"C" licence	8,347	540	10·4
Total	10,076	816	14·7
British Transport Commission			
Road Haulage Executive	799	58	4·0
Railway Executive	94	30	0·1
Total	893	88	4·1
Grand Total	10,969	904	18·8

(1) Including petroleum tankers but excluding vehicles licensed by farmers at special rates.

The salient feature of the table is the major importance of "C" licence work. These vehicles account for over 75 per cent. of the vehicle miles, 54 per cent. of the ton miles and nearly 60 per cent. of the tonnages carried by road goods transport. It is perhaps worth noting that those types of work which are generally regarded as most typical of "C" licence operation, such as local delivery of food, milk, clothing, etc., help to account for the large proportion of total vehicle mileage but do not constitute a big volume of traffic in terms of tons or ton miles, and so have little influence on these two statistics and those derived from them. British Transport Commission vehicles (of the Road Haulage and Railway Executives) account for about 8 per cent. of the vehicle miles, nearly 10 per cent. of the tonnage carried and about 22 per cent. of the ton mileage.

Section D.—The Place of Road Transport in the Domestic Carriage of Goods

Table 23 represents an attempt to put the general picture of road goods transport which has been arrived at as a result of this survey into its proper perspective as part of the domestic freight

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

transport of Great Britain. The figures given can only be regarded as the roughest approximations, the purpose of which is to give an indication of the comparative orders of magnitude rather than any precise measure of the traffic of the individual modes of carriage. The important feature which emerges from this table is that the net ton mileage performed by road goods vehicles is almost as great as that of the railways.

TABLE 23

British Domestic Freight Transport, 1952

	Tons Carried (Millions)	*Ton Mileage (Thousand Millions)*	*Proportions*	
			Tons Carried (per cent.)	*Ton Mileage (per cent.)*
Road	900	19	72	37
Rail	300(1)	22	24	43
Inland waterways	10(1)	—(2)	1	—
Coastal shipping	40	10(3)	3	20
Total	1,250	51	100	100

(1) Tons originating including free hauled traffic.
(2) 0·2 thousand millions.
(3) The "inland equivalent", that is the ton mileage by inland transport which would result if the coastwise traffics passed by inland means of carriage.

Acknowledgments

In conclusion it is felt that the operators of the various kinds of goods vehicles and their associations and the British Transport Commission are to be thanked for their co-operation in the sample enquiry. The organization and findings of the enquiry were founded upon the unstinted work of the staff in the offices of the Licensing Authorities for Goods Vehicles and of the Ministry of Transport and Civil Aviation, who are not of course responsible for the imperfections of this paper.

APPENDIX I

TABLE 24

Percentage Margin of Error(1) *of Mean Weekly Mileage*

(*Per cent.*)

Unladen Weight		*"A" Licence*	*Contract "A" Licence*	*"B" Licence*	*"C" Licence*	*British Transport Commission*	
Over	*Not Over*					*Road Haulage Executive*	*Railway Executive*
	12 cwts.	..	..	..	8·3	..	..
12 cwts.	1 ton	..	..	9·3	7·0	..	..
1 ton	2 tons	8·3	..	8·6	7·8	..	10·3
2 tons	2½ ,,	6·9	8·6	8·1	8·7	14·3	11·8
2½ ,,	3 ,,	8·1	8·3	8·8	7·5	7·2	10·4
3 ,,	5 ,,	8·1	8·0	7·8	8·4	7·6	11·3
5 ,,		8·9	..	..	7·8	6·5	..

(1) Twice standard error of the mean.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 25

Percentage Margin of Error(1) of Mean Weekly Ton Mileage

(*Per cent.*)

Unladen Weight		*"A" Licence*	*Contract "A" Licence*	*"B" Licence*	*"C" Licence*	*British Transport Commission*	
Over	*Not Over*					*Road Haulage Executive*	*Railway Executive*
1 ton	2 tons	11·6	..	13·3	12·2	..	13·5
2 tons	2½ ,,	13·5	13·1	13·9	14·7	24·0	14·0
2½ ,,	3 ,,	12·4	10·8	11·5	11·7	10·5	14·6
3 ,,	5 ,,	11·7	10·0	11·0	12·0	9·7	15·6
5 ,,		11·5	..	..	11·6	7·9	..

(1) Twice standard error of the mean.

TABLE 26

Proportions of Vehicles Engaged Wholly or Mainly in Carrying certain Commodities

(*Per cent.*)

	Under 12 Cwts. Unladen Weight, "C" Licence	*Over 12 Cwts. Not Over 1 Ton Unladen Weight*	
		"B" Licence	*"C" Licence*
Groceries, confectionery, fish, etc.(1)	21·3	33·3	20·3
Meat	11·6	4·3	6·1
Fruit and vegetables (except potatoes)	2·6	2·4	4·3
Live animals	0·7	1·4	0·3
Other agricultural produce(2)	8·6	8·2	5·0
Agricultural supplies(3)	4·1	1·5	4·5
Coal and other fuel	0·7	0·5	0·8
Timber	0·7	1·0	0·3
Building and constructional materials(4)	12·0	4·8	10·5
Metals and machinery(5)	1·5	1·5	1·6
Manufactured goods(6)	19·8	10·2	23·1
Materials for industry(7)	4·9	2·9	10·4
Furniture	0·7	4·3	2·9
Unallocated — homogeneous loads	3·7	6·8	2·1
Unallocated — mixed loads	7·1	16·9	7·8
Total	100·0	100·0	100·0
Number of vehicles(8)	85,125	2,286	269,161

(1) Groceries, bread and confectionery, fish, eggs, school meals, beer and tobacco.
(2) Milk, potatoes, grain, flour, beet, etc.
(3) Fertilisers, cattle food, farm implements.
(4) Sand, gravel, ballast, cement, bricks, tiles, hardcore, road-making material, rubble, etc.
(5) Iron, steel, girders, castings, etc.
(6) Cloth, clothing, electrical and gas appliances, glass, pottery, fancy goods.
(7) Including chemicals, glue, leather, plastics, rubber, fibres, etc.
(8) Total number of vehicles with carriers' licence or operated by the B.T.C. on September 30th, 1952, including tankers.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 27

Unladen Weight Over 1 Ton Not Over 2 Tons

(*Per cent.*)

	"A" Licence	"B" Licence	"C" Licence
Groceries, confectionery, fish, etc.(1)	7·8	8·0	19·9
Meat	3·2	—	1·7
Fruit and vegetables (except potatoes)	3·2	4·2	7·5
Live animals	0·5	0·4	—
Other agricultural produce(2)	1·3	1·9	8·7
Agricultural supplies(3)	—	—	3·5
Coal and other fuel	6·4	31·4	4·3
Timber	—	0·8	0·6
Building and constructional materials(4)	10·5	8·4	15·9
Metals and machinery(5)	1·8	1·5	1·4
Manufactured goods(6)	5·9	2·7	19·8
Materials for industry(7)	2·7	—	4·3
Furniture	10·0	9·6	2·0
Unallocated { homogeneous loads	12·0	5·4	2·9
Unallocated { mixed loads	34·7	25·7	7·5
Total	100·0	100·0	100·0
Number of vehicles(8)	3,460	8,926	201,344

For footnotes see Table 26.

TABLE 28

Proportions of Vehicles Engaged Wholly or Mainly in Carrying certain Commodities

Unladen Weight Over 2 Tons Not Over 2½ Tons

(*Per cent.*)

	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	British Transport Commission: Road Haulage Executive
Groceries, confectionery, fish, etc.(1)	6·5	6·1	3·5	13·7	11·0
Meat	2·9	0·8	1·8	0·9	1·8
Fruit and vegetables (except potatoes)	1·3	1·6	4·4	9·7	2·8
Live animals	3·9	—	1·8	1·2	1·8
Other agricultural produce(2)	5·1	4·0	4·0	5·8	2·7
Agricultural supplies(3)	1·9	5·7	2·4	3·2	0·9
Coal and other fuel	4·8	15·8	26·2	12·6	—
Timber	0·7	0·4	0·6	0·3	—
Building and constructional materials(4)	18·1	32·0	20·3	20·2	7·4
Metals and machinery(5)	1·9	2·0	2·9	2·9	3·7
Manufactured goods(6)	4·5	4·9	1·5	12·3	8·3
Materials for industry(7)	2·6	7·3	0·3	2·6	2·8
Furniture	13·2	3·6	9·7	2·9	3·7
Unallocated { homogeneous loads	4·9	4·5	1·2	1·2	1·8
Unallocated { mixed loads	27·7	11·3	19·4	10·5	51·3
Total	100·0	100·0	100·0	100·0	100·0
Number of vehicles(8)	11,685	3,163	21,674	124,196	6,700

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 29

Unladen Weight Over 2½ Tons Not Over 3 Tons

(*Per cent.*)

	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	British Transport Commission: Road Haulage Executive
Groceries, confectionery, fish, etc.(1)	4·7	4·6	4·3	14·0	5·6
Meat	2·5	—	1·4	0·9	1·9
Fruit and vegetables (except potatoes)	—	0·4	0·5	4·9	1·9
Live animals	10·5	—	6·6	0·9	1·9
Other agricultural produce(2)	8·7	7·0	4·3	4·4	5·2
Agricultural supplies(3)	3·7	4·6	5·7	4·1	1·5
Coal and other fuel	5·8	11·6	14·2	5·5	0·8
Timber	0·4	1·7	1·9	2·6	—
Building and constructional materials(4)	16·0	37·3	29·9	25·5	4·9
Metals and machinery(5)	2·2	7·1	0·5	5·8	4·9
Manufactured goods(6)	6·2	8·3	3·3	14·5	8·6
Materials for industry(7)	1·5	5·0	1·4	5·5	2·3
Furniture	12·7	1·2	9·5	4·4	2·3
Unallocated { homogeneous loads	2·9	1·2	0·9	1·5	2·7
Unallocated { mixed loads	22·2	10·0	15·6	5·5	55·5
Total	100·0	100·0	100·0	100·0	100·0
Number of vehicles(8)	16,309	5,456	23,658	94,656	13,300

For footnotes see Table 26.

TABLE 30

Proportions of Vehicles Engaged Wholly or Mainly in Carrying certain Commodities

Unladen Weight Over 3 Tons Not Over 5 Tons

(*Per cent.*)

	"A" Licence	Contract "A" Licence	"B" Licence	"C" Licence	British Transport Commission: Road Haulage Executive
Groceries, confectionery, fish, etc.(1)	7·9	5·7	2·6	14·4	6·4
Meat	2·5	—	3·0	—	1·6
Fruit and vegetables (except potatoes)	1·0	0·7	—	1·4	1·1
Live animals	20·3	1·9	16·9	1·6	1·6
Other agricultural produce(2)	7·9	4·4	2·6	5·9	5·4
Agricultural supplies(3)	3·5	5·0	2·3	4·6	1·6
Coal and other fuel	5·4	11·9	17·3	3·9	0·5
Timber	3·5	3·1	4·9	6·7	—
Building and constructional materials(4)	8·5	41·5	26·7	19·3	7·5
Metals and machinery(5)	3·0	5·7	1·5	6·0	8·1
Manufactured goods(6)	10·4	8·2	1·9	12·3	5·9
Materials for industry(7)	2·9	3·0	0·4	6·0	2·2
Furniture	6·9	—	11·3	4·2	1·1
Unallocated { homogeneous loads	1·0	3·2	1·2	5·0	1·1
Unallocated { mixed loads	15·3	5·7	7·4	8·7	55·9
Total	100·0	100·0	100·0	100·0	100·0
Number of vehicles(8)	6,848	2,661	5,401	40,122	9,900

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 31

Unladen Weight Over 5 Tons

(*Per cent.*)

	"A" Licence	"C" Licence	British Transport Commission: Road Haulage Executive
Groceries, confectionery, fish, etc.(1)	9·4	14·5	5·0
Meat	2·5	0·9	—
Fruit and vegetables (except potatoes)	—	0·9	0·9
Live animals	3·4	0·4	—
Other agricultural produce(2)	8·5	6·8	4·2
Agricultural supplies(3)	4·0	3·4	—
Coal and other fuel	4·0	0·4	—
Timber	6·0	6·4	—
Building and constructional materials(4)	11·5	20·5	5·0
Metals and machinery(5)	14·9	10·7	21·8
Manufactured goods(6)	5·5	13·2	8·8
Materials for industry(7)	7·9	9·0	1·9
Furniture	2·0	2·1	0·5
Unallocated { homogeneous loads	0·5	3·5	0·5
Unallocated { mixed loads	19·9	7·3	51·4
Total	100·0	100·0	100·0
Number of vehicles(8)	1,438	11,994	6,880

For footnotes see Table 26.

APPENDIX II

The Road and Rail Traffic Act, 1933, made it necessary for goods vehicle operators to obtain carriers' licences. There are four classes of carrier's licence:

(1) The Public Carrier's (or "A") Licence entitling the holder to use authorized vehicles for the carriage of goods for hire or reward and in connection with his business as a carrier of goods, but in general for no other purposes connected with the carrying of goods.

(2) The Contract "A" Licence for vehicles to be used exclusively on a contract (extending over a continuous period of not less than one year) made by the applicant with some person other than a carrier for the carriage of that person's goods in connection with his trade or business.

(3) The Limited Carrier's (or "B") Licence covering the use of authorized vehicles for the carriage of goods either in connection with any trade or business carried on by the licensee or (subject to any special conditions attached to the licence) for hire or reward.

(4) The Private Carrier's (or "C") Licence entitling the holder to use authorized vehicles for the carriage of goods in connection with any trade or business carried on by him, but not for the carriage of goods for hire or reward.

Applications for these licences are dealt with by the Licensing Authorities for Goods Vehicles, of which there are eleven. Applicants for "A" or "B" licences must show need for the facilities which they wish to provide, and these applications are dealt with at public enquiries, at which objections may be made by competitors. "C" licences are issued on application, and so are Contract "A" licences provided that the Licensing Authority is satisfied that the application is in order.

The Transport Act of 1947 set up the British Transport Commission and laid upon it the duty of taking over road haulage firms engaged to a predominant extent in long-distance traffic. This traffic did not include certain specialized movements such as furniture removals, meat or livestock carriage nor did it include any "C" licensed vehicles, as these were unaffected by the Act. The tests as to what was and what was not "long-distance" for this purpose were rather complicated but generally speaking it meant carriage for a distance of more than forty route miles. Moreover, all "A" and "B" licensed operators not taken over by the British Transport

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Commission (i.e. those primarily engaged in "short-distance" work) had to get a permit from the Commission if they wanted to carry goods for profit outside a radius of twenty-five miles from their operating centre. The operation of goods vehicles acquired under the Act and the granting of permits was delegated by the Commission to the Road Haulage Executive. British Transport Commission vehicles, whether of the Road Haulage Executive or of the Railway Executive did not require carriers' licences before the passing of the Transport Act of 1953 which did not become law until after the enquiry described in this paper had been carried out.

Appendix III

A Copy of the Questionnaire Used in the Sample

Vehicle No.:—

Goods Vehicle Return

(To be made pursuant to Section 1 of the Statistics of Trade Act, 1947)

1. Details of Vehicle

1. Type of fuel used: Petrol/Diesel.*

2. Type of Carrier's Licence: A: A Contract: B: C.*

3. Unladen weight: tons. 4. Carrying capacity: tons.

5. Year of manufacture:

* Strike out detail which does not apply.

2. Record of Week's Work

Date	Journey (*a*)		Miles Run			Goods Carried (*description*)	Max. Load *at any point on journey* (*b*)
			Loaded				
	From	*To*	*over 50% of weight capacity*	*under 50% of weight capacity*	*Empty*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

Date.....

(*a*) In the case of circular journeys, intermediate points sufficient to identify the journey made should be given.

(*b*) If your vehicle is not over one ton unladen weight you need not complete this column.

I certify that the above is a true record for or on behalf of .....

.....
(Name and address of operator)

Signature .....
Status in Firm, e.g.,
Proprietor, Director, Manager, etc.....

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Discussion on the Paper by K. F. Glover and D. N. Miller

Mr. Harris-Burland: I have read this paper with deep interest and am sure that that stimulating experience has been shared by all present, and that we all wish to offer our hearty congratulations to the authors for the courage and success with which they have tackled this difficult task. I do not agree with all their conclusions, but nevertheless one must recognize that their work makes a most important contribution to progress from three points of view.

Firstly, it demonstrates the value of applying statistical sampling to the transport industry, secondly, it makes a useful contribution to our scanty knowledge of road haulage, and thirdly—which I think is the most important—the speakers have pointed the way into new territory. As they rightly emphasize there is available very little comprehensive information on the question of road transport. Of the importance of the subject there can be no doubt. The rapid and widespread growth of road transport is a revolution which, on a smaller scale, is comparable with the industrial revolution of the last century. This transport revolution confers great benefits, but also creates great problems. Other western industrial countries have similar problems but in this crowded island they have a special urgency and importance. It is, I think, no exaggeration to say that nearly every person in these islands is profoundly affected by the economic and social changes which are being engendered by this remarkable growth of road transport. These changes can be of great benefit but if the full benefits are to be reaped this growth must be wisely guided and co-ordinated with other forms of transport. Wise guidance requires knowledge of the facts; for this reason, road transport constitutes a special challenge to the statistician to supplement the information which is at present so scanty.

This, I think, is the great value of the paper—it has stimulated a search for information upon this highly important growth of road transport and has shown how such information can be usefully and economically obtained by statistical sampling.

It is with the greatest pleasure that I propose a hearty vote of thanks to Mr. Glover and Mr. Miller.

Mr. Gresham Cooke: I have considerable pleasure in seconding the vote of thanks proposed by Mr. Harris-Burland. Obviously this paper is a result of very conscientious and thorough research and it adds an enormous amount to our knowledge of the road transport industry.

Knowing how scattered this industry is, made up into little parcels, and how difficult some of the members can be with regard to giving information, I think Mr. Glover and Mr. Miller have done a wonderful job in getting all they have out of them, even though they have had to go to only 1 per cent. It also shows, I think, what many of us have believed, that much valuable information can be obtained from a very small sample. We in the motor industry can never have enough information; there is not enough at the moment, and we want a great deal more. Quite apart from the general sociological problems we want more information on all sorts of things to plan the future sales of the motor industry products, the requirements for spare parts and so on in the years to come, and the more knowledge that can be gathered the more it will help an even flow of production and manufacture.

In the paper there is new knowledge, the age of vehicles, the tonnages carried, and so on and I was delighted to see that at long last, under Table 9, beer and tobacco have been counted as food! While on that subject, as one who travels on the Bath Road (A4) a good deal, I was very much interested in the analysis of the various kinds of other licensed vehicles and the use to which these vehicles are put, which I thought was clearly expressed.

I think we all agree that all knowledge is good knowledge on this subject and from my personal point of view, very vitally important some of it is. We are always struggling to convince the population—because it is a conservative population in England—that road transport is of any importance at all. We are generally told that all these goods should be dealt with on the railways and I was encouraged to read not only that road transport carries as much goods as the railways but that the road vehicle is ten times more efficient than the railway wagon of the same size. Considering the millions of vehicles, the millions of miles they run, the millions of tons which are carried, one wonders whether the road system of this country, so ably constructed in the nineteenth century, is adequate to carry these tonnages of the twentieth century. As Mr. Glover and Mr. Miller so ably bring out, a large part of the "C" licence business is merely the carriage of goods from one factory to another, those factories often being in the same ownership or industry, so that the lorry as it leaves one works and runs to another is merely an extension of the conveyor belt between one factory and another. When it is remembered that there are two factories which have a daily inflow and outflow of 700 lorries a day in each factory, one realizes the extent to which the industry of this country is dependent on road transport.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The vote of thanks was put to the meeting and carried unanimously.

Mr. PONSONBY congratulated not only the authors, but also the Ministry of Transport for permitting the investigation to go forward. It was very much hoped that the results of this investigation would some day appear in some official publication; and that some of the authors' findings would be kept up to date and published again at (say) five-yearly intervals.

He hoped that the British Road Federation would incorporate some of the results of the paper in that useful annual publication *Basic Road Statistics* which was so useful for quick reference. He was sure that the information given in the paper would get more widely known if it were allowed to appear in some popular form.

He would like to know whether what the authors had found out had brought them any great surprises. To him there were not many surprises, but one big surprise was the total volume of traffic hauled by the road haulage business as a whole. He did not think anyone realized that in terms of tons consigned the road haulage industry exceeded the rail industry: not actually in terms of ton mileage, he admitted, but very nearly.

Before coming to the meeting he broke up this figure of the ton miles hauled by rail, as Mr. Glover had said that in the terms of ton mileage carried, the road figure was 19,000 m. tons, and the rail figure 22,000 m. tons; but the rail figure included all the coal and minerals carried. If we compared the road figure, for example, with the general merchandise figure on the railways, the total road figure was 19,000 million, whereas "general merchandise" on the railways was only 7,000 million; most of the merchandise traffic carried by the railways could so to speak, not with great difficulty be negotiated by road transport. To get this into a right perspective was most interesting and that was possibly the big surprise of this investigation, i.e., that the total ton-mileage on road and rail was: road, 19,000 million, rail 22,000 million, 10 million of which was coal, five minerals, and seven merchandise.

One last point with regard to the "user" of old and new vehicles. It would be seen that the older vehicles got much less intense use than the new vehicles. That no doubt was because the operating costs of old vehicles were usually higher than those of the new vehicles because they were old, and if there was a slack time and there was a question of using one or the other the new one was used in preference to the old. In the United States, so far as old and new *buses* were concerned, there were circumstances in which the old ones were used exclusively for the peak period whereas the new ones were used all day.

Mrs. Cox said that in 1951 the Transport and Communications Commission of the United Nations stressed in its report the great importance of obtaining reliable figures for the transport of goods by road motor vehicle, particularly the series for the tonnage of goods loaded and for the net ton miles performed by this type of transport. At the same time it was recognized that in most countries, if not in all, a sampling technique was the best method of obtaining the figures.

Such figures were contained in this paper and it was particularly gratifying that in completing this study of the road goods transport industry Mr. Glover and Mr. Miller had put the United Kingdom in the forefront of this type of statistical and economic research. She had wondered what proportion of goods moved in this country went by road, but despite the published figures of the growth of the vehicle fleets she was not prepared for the answer in Table 23—about 72 per cent. of the tons carried and 37 per cent. of the ton-mileage. To the layman this was astonishing news; road transport was no longer an up-and-coming competitor in the field of domestic freight transport but a full partner.

Nothing was known of traffic on the roads before the war. The number of road goods vehicles had doubled and, with the greater capacity of the vehicles, it was reasonable to suppose that the traffic had more than doubled. This increase had taken place despite increasing contributions to the Exchequer and certain restrictions on the use of vehicles.

The authors pointed out that it was not possible to estimate the extent to which the institutional framework encouraged or discouraged the use of this vast mass of capital equipment. This was certainly true. Clearly, where one authority was the sole carrier it could permit a queue of traffic to form and so ensure its vehicles would run loaded. But this situation, so satisfying to the Transport manager, might involve much inconvenicnce to users and might also involve loss of goodwill of customers abroad. It was the operators' advantage of intensive vehicle use balanced against the users' need of swift and timely delivery. This dilemma had surely contributed to the growth of the "C" licence vehicle fleet. By running his own vehicles a manufacturer gained complete control over the transport to and from his factory; he guaranteed continuity on his production line and quick and certain delivery of his products. With growing world competition this trend was unlikely to be reversed.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The figures in Table 1 illustrated vividly the importance attached to these factors by industrial concerns: 83 per cent. of all road goods vehicles were in the private carriers' class, and of the larger vehicles of 2½ tons unladen weight and over, 60 per cent. were in this class. Since return loads could not be accepted unless in connection with the operators' own trade or business, it was encouraging to see in Table 2 that the "empty" percentage was 32 per cent. or under. Clearly, if this block of up-to-date capital equipment could be more intensively used, its productivity would be greatly increased and many manufacturers' costs might be considerably reduced.

Dr. BUCKLAND said that he had been privileged to follow this enquiry closely enough to realize its fundamental importance to the study of the road goods industry. He would go further than Mr. Harris-Burland and ask whether the material which had been so carefully gathered in this survey could be written up into the much needed manual on the operation of this particular branch of inland transport. He was sure that future generations of students in this branch of industry deserved to have the manual that they had so long awaited.

On the point of the design and execution of the survey he did not think there was much one could say by way of constructive criticism. It was true that it was possible that the constant interval of selection might have resulted in some lack of balance but if one tried to avoid that possibility the organization necessary for the survey would have been that much more complicated and very much more likely to go wrong. The whole enquiry, in fact, bore strong evidence that what could be done was done with the personnel and material involved. As he had discovered himself in connection with the passenger side of the industry, one could ask questions which people would answer. But if many other questions were asked, however badly one wanted the answers and the results, one knew the response would be "flavoured with a strong smell of cooking". It was an old statistical principle that the validity of any analysis must be conditioned by the accuracy of the basic data.

He noticed the paper did not contain a reproduction of the questionnaire actually used in the survey. This might be due to regard for space in the *Journal*. But if it could be included it would be of assistance because one could never see too many special designs of questionnaire forms: they were useful in teaching survey techniques, and to see the questionnaire form actually used gave a very definite idea of the over-all scope of the enquiry, even more than the comprehensive set of tables given in the paper.

Finally, he would support Mr. Ponsonby's plea for the work to be repeated in a few years' time, say in 1957, because this kind of survey was so much more valuable when comparisons could be made with the past as well as showing what was going on in the present. In addition to supporting the vote of thanks accorded to the authors he congratulated the Honorary officers of the Society for having secured a paper so much in keeping with the long-standing traditions of the Society.

Mr. C. T. SAUNDERS thought the paper provided a set of statistics for which people interested in trying to explain certain recent economic developments had been waiting for a long time. It was a remarkable fact that the railways had for generations been obliged to provide traffic statistics weekly or monthly—statistics which road operators had now been persuaded to compile for one week. The railways, which now carried, apart from minerals and coal, a minor part of the country's freight, still had to perform these elaborate statistical operations whereas the road transport industry escaped very lightly. Perhaps this was one reason why the road transport industry had been able to go ahead so rapidly, and he hoped that this form of unfair competition would now disappear.

He would like to ask whether it was fair to draw a certain deduction from Table 23. It had been pointed out that the total amount of "general merchandise" was now 7,000 million ton miles on the railways, while the roads carried 19,000 million—not all "general merchandise". As Mrs. Cox had said, the total road transport fleet had doubled since before the war, and the total ton miles might have increased even more. Thus the ton mileage on the roads before the war might have been of the order of 5,000 million ton miles. Total rail traffic in general merchandise just before the war was about 5,000 million ton miles. Thus the rail-road proportion then was something like half and half and since just before the war the total ton mileage on road and rail together might have about doubled. Meanwhile the total national output of physical goods had risen by about one-third (by 1952).

This led to two interesting conclusions, if the figures were valid; first that almost the whole increase in the production of goods since before the war had been carried by the extension of road transport; secondly that goods must travel many more miles per unit of output than they did before, which might or might not be an indication of increasing economic efficiency.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Mr. A. A. ADAMS asked if the authors could give more details of the calculation of annual aggregates in section 13(*b*), with an opinion on their reliability. For many purposes the information in the paper would have to be used in this form. It would be useful to know what precisely the authors had done about the public and other holidays which they mentioned, and why they thought their particular week was representative. Considering the movements in industrial production he would have thought that deciding on a representative week was very tricky. Was it not possible to make some comparison with the figures available from the British Transport Commission workings so as to have some check on the method used for grossing up?

Mr. H. PALCA welcomed the fact that the authors had quoted the sampling errors in some detail in the Appendix.

There were two small points on the sampling procedure. Firstly, although it was not true that a constant sampling fraction had been used, the fraction had been chosen so as to equalize the sampling errors in each stratum. He was sure the authors would realize, although it had not been mentioned in the text, that this procedure did not minimize the over-all errors for total mileages and so forth. For that purpose they would, of course, have to take more from the quantatively more important groups.

Secondly, he gathered that a number of forms were not completed because the firms concerned had given up business. He wondered whether the effect of these omissions might be slightly to underestimate the age of vehicles, because the vehicles belonging to those giving up business might be of above-average age.

He felt sure that the paper would be a model for other sampling enquiries of a similar nature. Its results would certainly be useful for government statisticians in many departments.

Dr. F. GARWOOD asked the authors if it were possible to break down Table 22, particularly the aggregate vehicle miles according to the unladen weight of the vehicle. He had not examined the paper in detail to see whether it was possible to do so from the data which were actually printed but that information would be useful in comparing the accident rates of the different weight groups of vehicles; the number of vehicles in those weight groups which were involved in accidents could be obtained from the statistics which the department collected with the help of the police. A previous questioner said that little was known about trends in mileage statistics before the war but he imagined that some useful deductions (only approximate) might be obtained from the traffic census records which the Department had been taking for some considerable time. The counts taken at a number of fixed points every three years or so in a week in August would, he believed, enable some estimate to be made at least of the variation in the total vehicle-mileage from year to year. Those figures were, he believed, also divided according to weight groups, that is, each vehicle was classified according to its total weight; these figures might provide a very rough estimate of the variation in ton mileage.

Miss K. LIEPMANN said that she was interested in this paper from the town planning point of view and would like to emphasize that the increase of vehicles and of ton-miles, far outstripping the increase of production, was largely due to the policy of dispersal of population and of decentralization of industry; she wondered whether the authors had any material to show how much of the ton mileage was due to the spread of towns and to the setting up of branch factories in development areas which meant that much longer distances had to be covered

Mr. J. A. BOUND said that he was interested to see that in Table 23 the authors gave some estimates for total ton mileage performed by coastal shipping. He took part in making what he thought were the earliest published estimates for ton mileages of coastal shipping relating to 1950 and would like to know if Mr. Glover could say whether these were new estimates or had any connection with the earlier ones. He saw that the proportion of ton-mileage was rather higher in relation to that borne by the railways than in 1950, according to his memory.

The other point he intended to raise was in connection with one made by an earlier speaker in comparing the ton mileage performed by road and rail vehicles in the course of a week. If the comparison were made in respect of road and rail locomotives the answer would be rather different.

Mr. ERNEST RUDD submitted the following comments in writing:

I should like first to echo the well-deserved praises of this paper. The cost of transport accounts for a substantial part of the cost of the goods bought by consumers in this country. The efficiency of the industry is a subject on which many people have strong views, but, until this paper was

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

published there was a lack of facts on which to base an objective judgement. Although we still need to know much more on the subject, this paper is a substantial contribution to our knowledge.

However, "finality is death, perfection is finality, nothing is perfect", and so I would suggest two additions which might improve this paper, or further work of the kind. The authors have helped our interpretation of the paper by telling us the size of the possible sampling errors. But I have yet to meet any economic statistics in which sampling is the only source of error; indeed in many it is a relatively unimportant source. Can the authors tell us more about the other errors that may have occurred in this case? It would be particularly interesting to know if the vehicle operator's behaviour was affected by the knowledge that he had to fill in a form about the movements of one of his vehicles. He might, for example, have tended to send the selected vehicle off on long journeys, allocating other vehicles to the shorter journeys, in order to reduce the labour of filling in the form. Or he might have given the vehicle an unusual share of the work in order to impress the Ministry of Transport with the need to renew his carrier's license. Was any attempt made, perhaps informally, to discover if these biases were occurring, and if they were important?

Secondly, it seems to me that the results would be even more valuable if some attempt had been made to discover vehicle operators' receipts or expenditure, on the lines of the Census of Production. Figures for expenditure on local delivery services, for example, would be particularly valuable to the people who are now studying the costs of retail distribution. Further, these figures might give another picture of the relative importance of the various types of goods transport, differing from those shown in Tables 22 and 23. Lastly, if the total work done by goods vehicles were expressed in monetary terms it could more easily be seen in perspective against the rest of the economy.

Mr. GLOVER replied briefly expressing thanks for the reception of the paper.

Mr. MILLER replied to Mr. Ponsonby's question whether the results had presented any surprises to the authors, that he had been surprised by the number of vehicles at work in connection with building activities. A further surprise was the amount of work done by vehicles on long hauls particularly by "C" licence vehicles, his preconceived opinion of which had been that they were used mainly for local delivery of foodstuffs, etc.

The authors subsequently replied in writing as follows:

Mr. Ponsonby, Dr. Buckland and others asked if the study could be repeated, say, every five years. It is not possible to give a definite answer but naturally it is hoped that it will be possible to carry out similar enquiries in the future.

Mrs. Cox mentioned the international interest being shown in road goods transport statistics. One of the motives for undertaking the sample survey in the first place was the request from the Transport and Communications Commission of United Nations and from the Inland Transport Committee of the Economic Commission for Europe.

Dr. Buckland wondered if the process of selecting every 20th sheet in the vehicle index might have given rise to bias. We doubt this: the sheets are arranged in alphabetical order of operators' names and it is difficult to see why the procedure should not give a random selection.

He also emphasized a point with which we quite agree, that in an enquiry of this nature it is essential to ask operators only for the kinds of information which they can fairly readily supply, and to use concepts and terms with which they are familiar. This is important if the response rate is to be good and the data are to be reasonably dependable, although it means that a considerable amount of computing work is needed to produce statistics such as ton miles. In response to Dr. Buckland's suggestion we have incorporated in the paper as Appendix III a copy of the questionnaire used in the sample.

Now that we know something of the present output of this industry, it is natural that we should next want to know something about the past. We doubt if the traffic movements index and the traffic census returns would be much help as suggested by Dr. Garwood. We are sceptical about the wisdom of using traffic census data as a means of estimating changes in vehicle mileage. It is doubtful whether changes in the number of vehicles passing a number of points (a rather small number of points in post-war censuses) in one week in August in one year and another bear a very close relationship to changes in vehicle mileage on the road system as a whole in complete years. Mrs. Cox has made probably the safest statement, that taking into account the growth in the number of vehicles, output has perhaps more than doubled since before the war.

Mr. Saunders asked if it is a legitimate conclusion that this growth means that all the increase in industrial output has been carried by road. Comparing 1938 with 1952 and working in terms

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of ton mileage total railway freight traffics rose by about 33 per cent.: general merchandise and livestock traffic rose by 31 per cent. It is, therefore, clear that the railways had a share of the increased traffic, including that falling in the highly rated general merchandise and livestock classes.

Over the same period total railway tonnage rose by only 7 per cent., general merchandise and livestock increased by 9 per cent. There was, therefore, an increase in the average length of haul on the railways. This was doubtless due to a tendency for short haul traffic to pass by road: it does not necessarily follow that every ton of output in the economy was carried further in 1952 than in 1938 but this may well have been the case. What in fact probably happened was a large proportionate increase in transport in general, both in terms of tons and ton mileage, as the national income grew. This seems to be a common feature of expanding economies and is a subject on which perhaps some research is needed.

It is perhaps pertinent to note that the increase in railway merchandise traffic mainly occurred before 1945, and that since then there has been a slight decrease in this traffic, although the coal, coke and minerals and heavy merchandise classes have increased. It may be a legitimate conclusion that until the road transport fleet had recovered from its wartime depletion the railways carried the major part of the increased output of merchandise but that in the post-war years the road transport industry has obtained much the greater part of the increase in this type of traffic.

Mr. Adams wonders whether the week chosen was sufficiently representative for it to be safe to base estimates for the year upon it. It was not possible to make the enquiry before the summer of 1952, and it was therefore a question of choosing a week about that time which, as we say in the paper, was not too seriously influenced by seasonal movements. There is, of course, a seasonal upswing in production during the autumn, so that it was important not to leave it too late, but on the other hand it was necessary to wait until after the holiday season. This pointed to the second half of September. An examination of the Central Statistical Office's Index of Industrial Production tended to confirm this: the index for August was strongly influenced by holidays and that for October by the autumn boom, but the figure for September was near the figure for the whole year. Certain other arguments and information, partly connected with the continuation of holidays into September, finally made us decide in favour of the last week of that month.

Mr. Adams further asks whether comparison had been made between the annual estimates for the Road Haulage Executive and the Railway Executive and the figures compiled and published by the British Transport Commission itself. In the case of the Railway Executive the correspondence both as regards vehicle mileage and tonnages carried was within one or two per cent., as near as can be judged. (The published figures for railway collection and delivery work give tonnage of freight but only numbers of parcels.) In the case of the Road Haulage Executive the figures published by the B.T.C. are not comparable with those in our paper as the former exclude work done by vehicles hired out under contract. Moreover, the tonnage figures are given on the basis of "tonnages originating" whereas the figures in our paper are on the basis of "tonnages carried".

Mr. Palca pointed out that the margins of error on the estimated aggregate vehicle mileages, tonnages and ton mileages were not minimized by trying to achieve uniform margins of error for each cell. This is true, but it was felt that the two purposes of comparing the sort of work done by the several categories of vehicle and of obtaining figures which would continue to be of use for departmental purposes in years during which no sample could be taken had to be given precedence over the desirability of minimizing the errors in the aggregates.

Mr. Palca wondered whether the non-response from operators who had gone out of business or who had sold their vehicles would be a source of bias in that old vehicles would be under-represented. If a vehicle was sold and subsequently scrapped, it was no longer a member of the population to be sampled, and it was therefore desirable it should be missed. If, however, it had been sold to another operator then it would not be a source of bias *unless* old vehicles tended to have a more rapid turnover than new vehicles. It is not easy to see how data could be obtained to check this one way or the other, but we do not think there is serious danger of bias from this source.

Dr. Liepmann wanted to know whether the enquiry threw any light on the effects of the latest developments in the urban sprawl. This is not really the sort of information that the sample enquiry was designed to discover. We are afraid that it is not possible from the information available to give any data about the extent of delivery areas, transport "hinterlands" or "catchment areas", or things of that nature. In any case, there is no previous information with which comparisons could be made.

Mr. Bound asked how the estimates for coastwise shipping were obtained. They were based on certain data, including Ford and Bound's "Coastwise Shipping and the Small Ports", the Ministry of Fuel and Power's Statistical Digest and certain other information appearing from time to time in the technical press. There has been a considerable development in the coastwise carriage of coal and petroleum in recent years, the former largely due to the siting of many electricity

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

generating stations near tidewater and the latter to the carriage coastwise of inputs and outputs of the new refineries.

In connection with Mr. Rudd's comments, we feel that Dr. Buckland mentioned an important consideration bearing upon his second point, namely that in an enquiry of this nature it is important to ask for the sort of information which can be fairly readily supplied. We refer to this in the paper under the heading of the organization of the sample enquiry. To ask for more either results in a lower response rate with consequent risk of bias or leads to difficulties in other directions and possible ill feeling. It is doubtful how far most operators would be able to give financial information of the kind that Mr. Rudd would require for the purposes which he has in mind. Those operators who did keep accounts would be unlikely to maintain them for individual vehicles, and this was a sample by vehicles. Moreover, there would probably have been additional difficulties resulting from differences between the periods covered by accounts and the period to which the physical statistics referred. To collect the kind of information which Mr. Rudd suggests would require a very different kind of enquiry, although we quite agree that it would be of considerable interest. We are inclined to think that further progress in obtaining information in money terms about the work of road goods transport will have to be made along the lines of Mr. Rudd's own paper to this Society on expenditure on road transport.

We agree with Mr. Rudd's first point that an enquiry of the nature of that discussed in the paper may be influenced by the outlook of those who fill in the forms. However, detailed scrutiny of each individual form did not reveal any sign of gerrymandering. And a desire such as Mr. Rudd postulates "to impress the Ministry of Transport" would not necessarily have led to an exaggeration of the work done.

Part of our answer to this comment would consist of the answer given to Mr. Adams above. We have given a general warning about the precision of the figures at the end of the Section on the organization of the enquiry and it is possible that errors of the kind suggested by Mr. Rudd have occurred, and his remarks will be borne in mind in planning any future enquiry, but we do not believe that they are such as to disturb the broad pattern of our findings.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

John Brands.
Frank Elliott Ashworth Briggs.
Patrick Branwell Brontë-Hearne.
John Frederick Davison.
Helen Hughes.
Stephen Lipton.
Moharram Wahby Mahmoud.
Richard Stanley Marriner.
Robert Raine Oswald.
Ahmed Ebada Hossein Sarhan.
William Anthony O'Neill Waugh.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Heights and Weights of the Army Intake, 1951

By S. Rosenbaum

Directorate of Army Health

Contents

PAGE

1. Introduction and description of data 331
2. Errors of measurement 331
3. Gains with age and with year of birth 333
4. Frequency distributions 335
5. Regression of weight and height 337
6. Standard deviations 339
7. Changes associated with year of birth alone 342
8. Standard tables 343
9. Effect of initial training 346
10. Summary 346

Introduction and Description of Data

1.1. There were measurements for 134,317 men who joined the Army during 1951, of whom 16,188 were Regular soldiers. These measurements were recorded during the first days of a man's service, and therefore give a picture of civilian standards, unaffected by the early training which is well known to change the weights (see para. 9.1). The National Servicemen are not representative of all young men in the country, as certain grades are rejected for service at an earlier stage by Ministry of Labour medical boards. (W. J. Martin (1949) has shown the differences to be expected in the rejected grades.) The same selection applies to young Regulars who go through these boards before taking on a Regular engagement, and there is also a rather stricter standard before they are accepted. Older men who join as Regulars will often have seen service before, but in this they are not untypical of the rest of the population of the same age. In addition medical standards may be relaxed somewhat for an older man with special qualifications. There are minimum standards for height and weight (usually 62 in. and 110 lb., or 60 in. and 100 lb. according to the Arm of Service); however, the distributions are not greatly truncated at the lower end since transfers take place to suitable arms, and the standards are not rigidly followed, as may be seen in the distributions of para. 4.1 and 4.2.

1.2. The ages in this survey have to be judged from the year of birth, and normally the average age of a group is the difference between the year of birth and 1951, since the joining up is evenly enough distributed through the year. But there is an exception with National Servicemen and many young Regulars, for call-ups are governed by birthdays, and all men called up for National Service in 1951 are about 18 years 3 months old when measured (including some born at the end of 1932). Similar bunching is likely to occur for the older National Servicemen who have been deferred for set periods. These considerations also influence the Regulars of the same ages, since a large number decide on a regular engagement when called up in the normal way, but they have less effect in the deferred groups. The Regulars born in 1934 must be at least 17½ years old when enlisting.

Errors of Measurement

2.1. The instructions for taking measurements lay down that men will wear trousers and socks, but it is not certain that this is adhered to, for instance, trousers may be interpreted as shorts (everyone is aware that the ideal is a stripped measurement). Consequently, rather than make an arbitrary adjustment, which we have not sufficient knowledge to rely on, the results in this paper are presented without correction for clothing. This at any rate enables direct comparisons to be made with other Services' measurements. Other writers have used corrections of 2 or 3 lb. for weight and ¼ in.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

for height in similar situations; the latter seems excessive at first sight, but G. M. Morant (1948)* in a sample taken in December obtained this excess of height in socks for R.A.F. aircrew.

The only comparisons we shall be making (in para. 3.2) are with the series analysed by W. J. Martin (1949). The men concerned were being called up to the Forces in 1939 and were probably being examined in the same way as to-day. Martin says, "The physical measurements were taken without clothing", that is to say he makes no corrections. Nevertheless one supposes that this was in practice interpreted just as it is now.

2.2. Weights are supposedly taken to the nearest pound, and heights to the nearest quarter of an inch in the present series; however, it is quite clear from an inspection of frequencies that it is common to make more sweeping approximations. For example out of 2,000 height measurements (about a week's intake selected at random), the numbers at each quarter inch were:

0	807
¼	254
½	698
¾	241

Weights are favoured at the exact stone and half-stone, with neighbouring poundages suffering in consequence. For example, in the largest age-group born in 1933, the numbers within a stone or so of the average were:

Wt. (*lb.*)	n
123	1,093
124	1,317
125	1,052
−126	1,897
127	1,078
128	1,436
129	1,277
130	1,542
131	1,334
132	1,472
−133	1,958
134	1,333
135	1,407
136	1,540
137	1,208
138	1,551
139	1,182
−140	2,051
141	1,013
142	1,300
143	1,183
144	1,213
145	1,118
146	1,097
−147	1,428
148	899
149	798
150	987
151	710

There are almost as many shown as weighing 140 lb., exactly 10 stone, as the neighbouring two weights together (and each of these is low again compared with the next neighbour). The position is similar at 9 stone, and almost as marked at 9½ and 10½ stone. Another phenomenon is the preference for even numbers against odd. The numbers in even weights listed above from 124 to 150 lb. are 19,635, while in odd weights from 123 to 149 they are 17,129 (from 125 to 151 lb. the figure is 16,746). If the stone and half-stone weights and their neighbours are omitted (because the stones are automatically even), the remaining even frequency is 10,886, against the corresponding odd frequency of 9,418 (or 9,035).

2.3. Finally, a word may be added on clerical errors (and coding and punched card errors).

* Dr. Morant has kindly made available to me a series of his papers on heights and weights in the R.A.F. which has been of great value.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

These were not detectable in the ordinary way; that they occur is certain from an examination of the records of a few subjects (see para. 9.1) who were measured again at short intervals. Another revelation from the final summary of results was that 41 National Servicemen were apparently born before 1927, including one whose year of birth was given as 1902. These were excluded from the calculations; they represent $1\frac{1}{4}$ per cent. of those aged 25 and over.

2.4. The results were calculated from the weights as given, without corrections for grouping. They are taken to be central values. The heights were only taken to whole inches, for example 67-in. represents heights from $66\frac{7}{8}$ in.–$67\frac{7}{8}$ in. Therefore a correction of $\frac{3}{8}$ in. has been applied where necessary to obtain central values. This is stated explicitly, as other investigators have used slightly different corrections, depending on their faith in the continuity of the measurements. No other correction is made for grouping (as in standard deviations).

TABLE 1

Average Weights and Heights by Year of Birth

	Regulars			*National Servicemen*		
Born	n	*Wt. (lb.)*	*Ht. (in.)*	n	*Wt. (lb.)*	*Ht. (in.)*
1902–1910*	84	148·44	67·67	—	—	—
1911	43	149·02	66·98	—	—	—
1912	50	149·36	67·76	—	—	—
1913	57	146·54	67·52	—	—	—
1914	79	147·47	67·29	—	—	—
1915	85	144·27	67·06	—	—	—
1916	123	150·45	68·29	—	—	—
1917	116	146·53	67·54	—	—	—
1918	125	147·70	67·68	—	—	—
1919	160	147·48	67·63	—	—	—
1920	217	143·94	67·85	—	—	—
1921	244	144·40	67·47	—	—	—
1922	304	146·44	67·72	—	—	—
1923	362	143·95	67·60	—	—	—
1924	405	143·61	67·49	—	—	—
1925	404	143·70	67·54	—	—	—
1926	546	141·82	67·63	—	—	—
1927	595	141·62	67·59	58	151·33	69·15
1928	711	143·20	67·85	230	148·63	69·08
1929	670	142·00	67·68	4327	144·88	68·29
1930	896	142·13	67·90	13840	143·11	68·13
1931	823	141·04	67·93	7240	142·29	68·10
1932	2019	140·28	67·97	33606	137·90	67·78
1933	5872	137·73	67·86	58703	136·93	67·75
1934	1282	136·63	67·71	—	—	—

* Mean year is at 1908.

*Gains with Age and with Year of Birth**

3.1. The numbers in each age-group, and their average weight and height are given in Table 1. The Regulars show a generally increasing weight with earlier year of birth, and slightly decreasing height. These facts are generally ascribed to changes in body structure, but also sometimes to changing social conditions and food habits. It certainly seems true that the younger age-groups have become heavier over the years, but no comparable data exist for older groups, and the truth may be only that maturity is reached earlier. In the present paper, where an age element is brought in, it is strictly meant as a reference to the year of birth. The differences of National Servicemen from Regulars can be accounted for by the remarks in para. 1 about age-bunching mainly, and to a small extent different standards; with the deferred National Servicemen there is also a selection of social groups.

* Some writers use the metric system for measurements. Conversion factors are given here for convenience:

1 cm. = 0·3937 in.
1 kg. = 2·2046 lb.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3.2. It is peculiarly difficult to make comparisons with other series. Even if the data presented here were available in the same form for previous decades, it would be a question whether a few thousand recruits to the Regular Army represented a nation-wide standard, and whether, as times change, different types of people come forward to join the Army. To discuss briefly just one of the series that might be considered appropriate for comparisons, W. F. F. Kemsley (1950) has published results of a Ministry of Food survey in 1943. This was in the middle of the war and was based on volunteers in factories, a representative sample being chosen. The results were, for men in the age-groups considered here :

Age	n	*Wt.* (*lb.*)	*Ht.* (*in.*)
35–39	3,414	139·0	66·64
30–34	3,139	138·4	66·73
25–29	1,962	136·3	66·76
24	368	135·3	66·83
23	477	135·0	67·04
22	460	136·0	67·34
21	467	131·6	66·92
20	591	131·2	66·94
19	786	127·8	66·74
18	1,280	124·5	66·31

It should be noted that the heights were reduced by 1 in. and the weights by 10 lb. to counteract the effect of measurements being taken fully clothed. Little could be deduced from comparing these with the results of Table 1, except that a different population was being considered, which is so, almost by definition. The civilian population in 1943 obviously excludes those who are in the Services, whether because of fitness or by reason of being in a reserved occupation.

3.3. Of previous series published, the most instructive for comparison seems to be that of W. J. Martin (1949), for men aged between 20 and 21 in 1939, before war broke out. (As stated in para. 2.1, the effect of clothing is assumed to be similar in the present series.) The weights in Martin's paper are given in groups of 5 lb. and it appears from recalculating the measurements for men placed in Grade I, that corrections used for central values were $2\frac{1}{2}$ lb. and $\frac{1}{2}$ in. The assumption would have been that weights were quoted at the number of exact pounds, ignoring fractions over, and heights similarly. The present paper uses different assumptions based on the instructions for measuring to the nearest pound and quarter of an inch, and would reduce these corrections by $\frac{1}{2}$ lb. and $\frac{1}{8}$ in. A further point is that Martin has shown the fitness gradings to have different physical measurements. The Ministry of Labour gradings in 1951 appear to be rather different from those in 1939, but we can reasonably collate the present series with all but Grades III and IV in 1939. The comparable averages then in 1939 were:

135·6 lb. and 67·4 in.

(The author stated incidentally that maximum stature at that time was reached about the age of 21.)

The figures for 1951 are about 6 lb. heavier and $\frac{1}{2}$ in. taller (using the Regulars to avoid selection in deferred National Servicemen). The maximum height appears to be at the age of 19 or 20.

The recruits of 1939 were born in 1918 or 1919, and this generation reached in 1951 an average about 12 lb. heavier than in 1939 (1 lb. a year). This gain in the growth of a particular generation is double the difference noted at a given moment between men with different years of birth. In tabular form, this can be stated as follows:

	Wt. in 1939 (*lb.*)	(12-year interval)	*Wt.* in 1951 (*lb.*)
Born 1918–19 . . .	$135\frac{1}{2}$		$147\frac{1}{2}$
(12-year interval)			$141\frac{1}{2}$
Born 1930–31 . . .	—		

It cannot be assumed, of course, that this applies *pro rata* to all shorter intervals. For years of birth close together, the difference in weights is a good indication of the prevalent rate of growth.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Frequency Distributions

4.1. To obtain a detailed picture of the frequency distributions of heights and weights would require a lot of smoothing, as is evident from para. 2. Only an outline is shown below, for the National Servicemen born in 1933 (mostly aged about 18 yr. 3 mth.).

Wt. (*lb.*)	n
80–89	5
90–99	144
100–109	1,360
110–119	6,568
120–129	12,229
130–139	14,527
140–149	12,100
150–159	6,537
160–169	3,079
170–179	1,203
180–189	526
190–199	232
200–209	87
210–219	60
220–229	28
230–239	9
240–249	6
250–	3
	58,703

This shows the well known skewness. Quantiles (from the detailed distribution) are at the following approximate values:

Median weight		135 lb.		
Quartiles		126	147	
Deciles	117			158

The median is more exactly at 135·5 lb. By the usual estimate which places the median at two-thirds of the distance from the mode to the mean, the mode can be supposed to lie at 132·6 lb.; this is useful in sketching the distribution. It is also useful to observe that the mean is almost mid-way between the deciles, which are about two-and-a-half standard deviations apart. (These remarks are also approximately true for the selected groups at a constant height.)

4.2. The distribution of heights for the same age-group is given below (see para. 2.4 for account of grouping).

Ht. (*in.*)	n
59 and under	23
60–	169
61–	439
62–	1,030
63–	2,116
64–	3,947
65–	5,965
66–	8,012
67–	9,089
68–	8,763
69–	7,132
70–	5,314
71–	3,320
72–	1,884
73–	876
74–	383
75–	153
76–	63
77 and over	25
	58,703

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The quantiles must be estimated from this distribution as given. They lie at the following points:

Median height		67·7 in.		
Quartiles	66·0		69·5	
Deciles	64·4			71·1

The distribution is symmetrical, and in fact approximately normal.

TABLE 2

Joint Frequency Distribution of National Servicemen Born in 1933

In.: / *Lb.*	53–	55–	57–	59–	61–	63–	65–	67–	69–	71–	73–	75–	77–	79–
80–89	—	—	—	—	1	4	—	—	—	—	—	—	—	—
90–99	—	—	—	18	73	35	12	5	1	—	—	—	—	—
100–109	—	—	1	59	358	529	331	71	10	1	—	—	—	—
110–119	1	—	4	54	616	2031	2534	1104	209	13	2	—	—	—
120–129	—	3	—	21	275	2008	4528	3924	1275	180	10	5	—	—
130–139	1	—	2	16	98	994	3879	5737	3003	702	88	5	2	—
140–149	—	—	2	5	33	321	1849	4304	3912	1428	223	22	1	—
150–159	—	—	1	4	8	84	549	1778	2326	1400	335	50	2	—
160–169	—	—	—	—	4	31	191	600	1065	820	316	43	8	1
170–179	—	—	—	—	2	16	55	183	371	365	163	44	4	—
180–189	—	—	—	—	—	7	30	72	154	170	63	26	3	1
190–199	—	—	—	—	1	2	13	43	65	64	31	12	1	—
200–209	—	—	—	—	—	1	5	12	24	27	12	5	1	—
210–219	—	—	—	—	—	—	1	12	18	16	9	3	1	—
220–229	—	—	—	—	—	—	—	6	9	11	1	1	—	—
230–239	—	—	—	—	—	—	—	1	2	3	3	—	—	—
240–249	—	—	—	—	—	—	—	—	1	3	2	—	—	—
250–259	—	—	—	—	—	—	—	—	1	—	—	—	—	—
260–269	—	—	—	—	—	—	—	—	—	1	1	—	—	—

The groupings are explained in para. 2.4 and para. 4.3.

TABLE 3

National Servicemen Born in 1933

Av. Wt. at each Ht.		*Av. Ht. at each Wt.*	
In.	*Lb.*	*Lb.*	*In.*
59 and under	125·17 ($n = 23$)	–89	63·18 ($n = 5$)
60–	113·30	90–99	62·74
61–	113·31	100–109	63·92
62–	116·11	110–119	65·30
63–	119·91	120–129	66·60
64–	124·21	130–139	67·68
65–	127·53	140–149	68·68
66–	131·38	150–159	69·58
67–	135·33	160–169	70·22
68–	139·03	170–179	70·70
69–	143·16	180–189	70·78
70–	147·34	190–199	70·58
71–	151·59	200–209	70·86
72–	155·29	210–219	71·00
73–	158·82	220–229	70·58
74–	162·35	230–	71·98 ($n = 18$)
75–	166·27		
76–	167·57		
77 and over	169·92 ($n = 25$)		

4.3. The joint distribution of heights and weights among the National Servicemen born in 1933 is given in Table 2 in groups of 2 in. and 10 lb. Fig. 1 shows frequency contours of ten, a hundred, and a thousand men in these groups, displaying a roughly triangular shape. Also mean weights at each height, and mean heights at each weight are plotted (Table 3). Within the limits 62 in. to 74 in. and 100 lb. to 170 lb. weight and height show a reasonably linear dependence.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Outside those limits there seems to be a tendency for the heaviest people to average a little under six feet in height, while the really tall ones average about twelve stone in weight. These marked "spurs" in the distribution are not matched at the lower end (at least not clearly), and although one can observe that the shortest people weigh about eight stone on the average, and the lightest average about five feet three inches in height, this phenomenon of separation follows from the geometry of the situation. (Some slight complication is introduced by the minimum standards mentioned in para. 1.1.)

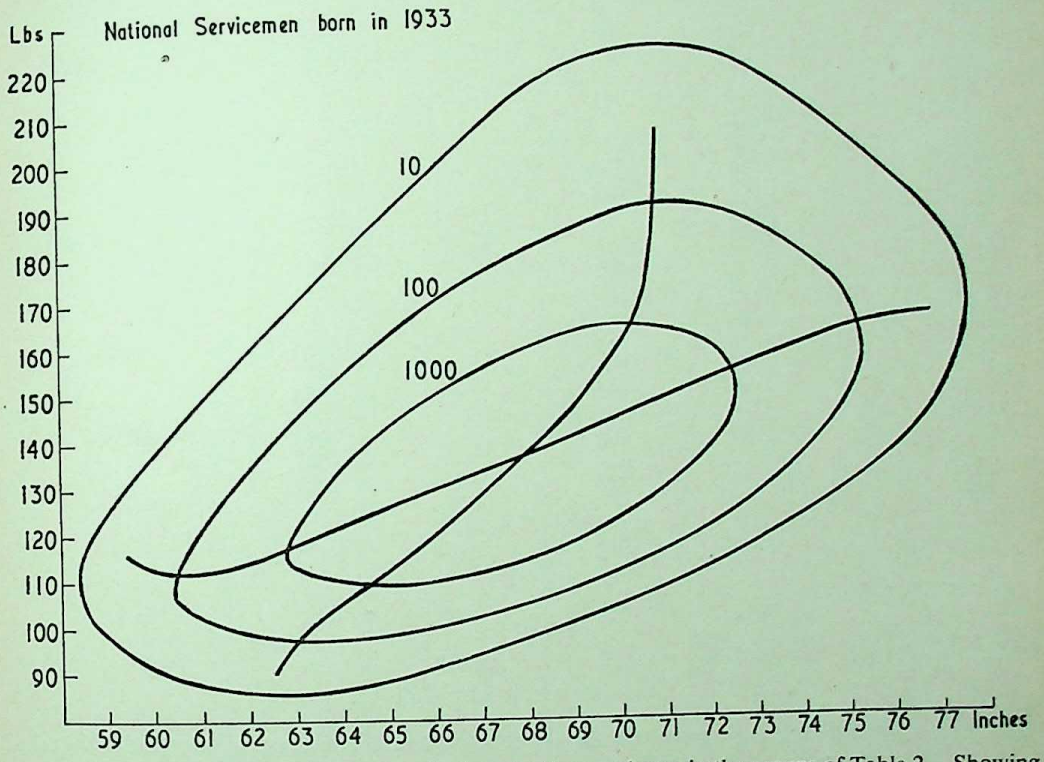


FIG. 1.—Frequency contours of ten, a hundred, and a thousand men in the groups of Table 2. Showing also mean weights at each height, and mean heights at each weight.

Regression of Weight and Height

5.1. Weights and heights are closely related apart from the influence of age, and Morant (1948) and others have recommended standardizing for height in all weight comparisons. Although the connection between the two is in reality complex, this is a useful and simplifying step. The natural way to look at it is to regard weight as depending on height: further this appears to give a straighter line than height on weight; naturally a linear law is easier to work with. In this paper we shall give regression slopes for both weight on height, and height on weight, using all the data; but in applying them, we keep within the limits mentioned in para. 4.3. Table 4 gives these slopes at each year of birth.

5.2. The average slope of the line height on weight is obviously reduced by including the heavyweights in the calculations. The line weight on height appears to give a good fit, although a formal test shows a significant departure of the array means from linearity.

Weights of National Servicemen Born in 1933

	Sum of Squares	*D.F.*	*Mean Square*
About linear regression . .	10,426,231	58,701	
About array means . . .	10,396,358	58,677	177·2
Departure from linearity . .	29,873	24	1,244·7

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Linear Regression Slopes of Weight on Height and Height on Weight at each Year of Birth

	Regulars		*National Servicemen*			
Born	*Wt./Ht.* (*lb. per in.*)	*Ht./Wt.* (*in. per lb.*)	*Wt./Ht.* (*lb. per in.*)	*Ht./Wt.* (*in. per lb.*)		
1902–1910*	3·29	·052	—	—		
1911	2·66	·040	—	—		
1912	3·96	·053				
1913	3·26	·068	—	—		
1914	4·26	·095	—	—		
1915	3·98	·075	—	—		
1916	4·54	·062	—	—		
1917	4·78	·077	—	—		
1918	3·39	·072	—	—		
1919	3·70	·074	—	—		
1920	3·64	·082	—	—		
1921	4·29	·078	—	—		
1922	3·89	·074	—	—		
1923	3·71	·081	—	—		
1924	3·70	·086	—	—		
1925	3·70	·076	—	—		
1926	3·46	·098	—	—		
1927	3·78	·092	3·51	·060		
1928	4·07	·097	3·78	·083		
1929	3·49	·095	3·63	·080		
1930	3·73	·106	3·74	·081		
1931	3·93	·096	3·82	·089		
1932	3·83	·107	3·85	·096		
1933	3·78	·102	3·86	·094		
1934	3·59	·093	—	—		
Av. after 1910	3·80	·082	3·74	·083		
					Total	
Common slope (after 1910) .	3·78	·096	3·83	·092	3·83	·092
Overall slope (after 1910) .	3·74	·092	3·88	·091	3·86	·091

* Mean year is at 1908.

Fig. 2 shows the difference of array means from the values predicted by the straight line, in relation to twice the standard error of the means.

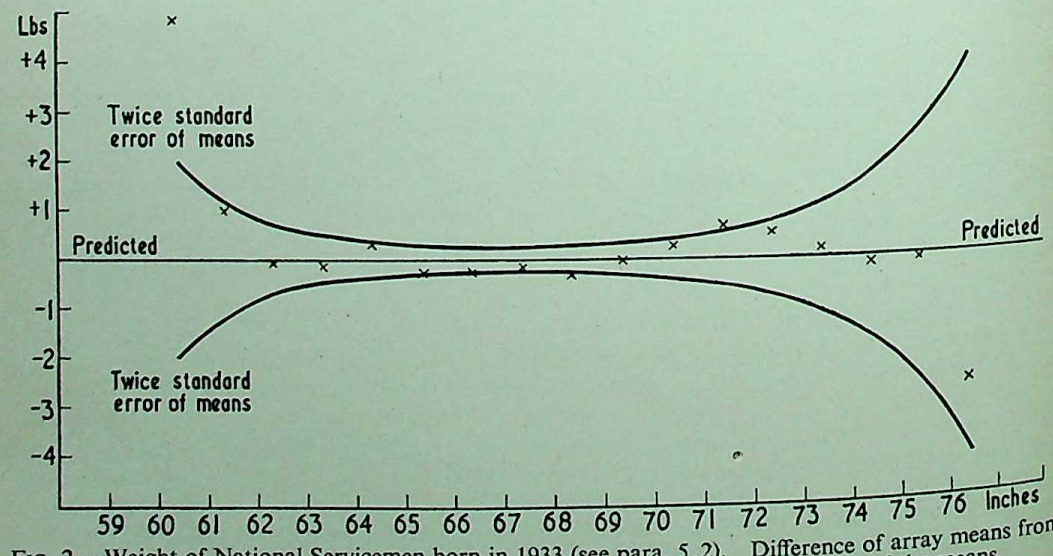


FIG. 2.—Weight of National Servicemen born in 1933 (see para. 5.2). Difference of array means from values predicted by linear regression; in relation to twice the standard error of the means.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5.3. There is no significant change in slope over time (or with increasing mean weight), of the regression weight on height. Height on weight increases at an average rate of ·002 every year. (These calculations were carried out on Regulars only). The latter simply reflects the increase of the variance in weight, with age (or rather with weight).

At the foot of Table 4 are shown the slopes obtained by pooling all the data after 1910, allowing and not allowing for separate means (called respectively common and overall slopes). These obviously are governed by the large group of 18-year-olds.

TABLE 5

Standard Deviations; and Residual Standard Deviations when the Regressions of Table 4 are Removed

	Regulars				*National Servicemen*			
	Wt. (lb.)		*Ht. (in.)*		*Wt. (lb.)*		*Ht. (in.)*	
Born	(*s*)	(*sr*)	(*s*)	(*sr*)	(*s*)	(*sr*)	(*s*)	(*sr*)
1902–1910*	18·63	17·05	2·35	2·15	—	—	—	—
1911	17·02	16·29	2·08	2·00	—	—	—	—
1912	23·09	20·72	2·68	2·41	—	—	—	—
1913	17·80	15·84	2·57	2·29	—	—	—	—
1914	19·86	15·43	2·96	2·30	—	—	—	—
1915	18·26	15·40	2·50	2·11	—	—	—	—
1916	19·08	16·23	2·23	1·90	—	—	—	—
1917	22·58	18·00	2·87	2·29	—	—	—	—
1918	18·23	15·93	2·65	2·31	—	—	—	—
1919	19·43	16·62	2·74	2·34	—	—	—	—
1920	17·67	14·85	2·65	2·23	—	—	—	—
1921	19·21	15·70	2·59	2·12	—	—	—	—
1922	19·13	16·18	2·63	2·23	—	—	—	—
1923	17·35	14·53	2·57	2·15	—	—	—	—
1924	16·76	13·87	2·55	2·11	—	—	—	—
1925	17·81	15·11	2·56	2·17	—	—	—	—
1926	16·54	13·45	2·79	2·27	—	—	—	—
1927	16·75	13·55	2·61	2·11	19·19	17·22	2·50	2·24
1928	17·23	13·43	2·65	2·07	18·40	15·26	2·74	2·27
1929	16·22	13·27	2·68	2·19	17·59	14·81	2·62	2·20
1930	16·15	12·56	2·72	2·12	17·18	14·33	2·53	2·11
1931	16·42	12·95	2·57	2·03	17·13	13·92	2·62	2·13
1932	16·31	12·54	2·73	2·10	16·73	13·30	2·64	2·10
1933	16·13	12·62	2·65	2·08	16·70	13·33	2·60	2·08
1934	15·94	13·01	2·57	2·10	—	—	—	—
Av. after 1910	17·96	14·92	2·62	2·17	17·56	14·60	2·61	2·16
Pooled S.D. (after 1910)	16·65	13·31	2·65	2·12	16·83	13·54	2·61	2·10
Overall S.D. (after 1910)	16·92	13·70	2·65	2·15	17·02	13·67	2·61	2·10

	Total			
Pooled (after 1910)	16·81	13·51	2·61	2·10
Overall (after 1910)	17·02	13·69	2·62	2·11

* Mean year is at 1908.

Standard Deviations

6.1. Table 5 gives standard deviations at each year of birth, and residual standard deviations when the contributions of the regressions in Table 4 are removed. (Note that from Table 5 and the values of n in Table 1, the standard errors of the regression coefficients in Table 4 can be constructed.)

We may observe that the standard deviation of weight of the Regulars born in 1933 is significantly smaller than that of the National Servicemen, although they are comparable in average weight and height. This is probably due to stricter application of minimum weight standards to the Regulars. Percentages of Regulars in this age-group below 100 lb. and 110 lb. are 0·17 per cent. and 1·84 per

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

cent. respectively, while for National Servicemen they are 0·25 per cent. and 2·57 per cent. respectively.

6.2. The comparative steadiness of the standard deviations of height from age to age, while the standard deviations of weight increase with age, leads to the question whether this happens within age-groups, and is in fact due to changes in weight.

Taking once again the largest group, National Servicemen born in 1933, the standard deviations of heights at each weight with more than 1,000 men are:

Wt. (*lb.*)	*S.D. of Ht.* (*in.*)	*Av. Ht.* (*in.*)
119	1·92	65·82
120	1·98	66·08
121	1·94	66·12
122	1·97	66·29
123	1·89	66·49
124	1·90	66·49
125	1·92	66·61
126	1·95	66·78
127	2·06	66·83
128	1·91	66·93
129	1·98	67·05
130	1·99	67·24
131	1·93	67·19
132	1·97	67·49
133	2·04	67·49
134	1·97	67·72
135	1·93	67·73
136	2·03	67·86
137	1·94	67·90
138	2·03	68·04
139	2·07	68·24
140	2·03	68·25
141	1·97	68·45
142	2·06	68·51
143	2·05	68·62
144	2·05	68·78
145	2·11	68·75
146	2·04	68·69
147	2·07	69·07

There is evidently a slight increase in the standard deviations of height, as weight increases. Taking the average of five at each end, there is a change in S.D. of ·12 in. over 24 lb., i.e., ·005 in. per lb. Looking again at the residuals in Table 5, there appears to be an average change of about· 07 in. in ten years, during which time, as we shall see, the weight changes by about five pounds. Only about one-third of this change in the standard deviation of heights would appear to be due to the change in weight alone. The residual variation not accounted for by the regression line is slightly larger than the average at each weight, as might be anticipated.

6.3. Turning now to the more striking changes in standard deviations of weight, we have again for the largest group:

Ht. (*in.*)	*S.D. of Wt.* (*lb.*)	*Av. Wt.* (*lb.*)
60–	12·59	113·30
61–	12·16	113·31
62–	10·83	116·11
63–	10·93	119·91
64–	11·82	124·21
65–	11·95	127·53
66–	12·49	131·38
67–	12·90	135·33
68–	13·32	139·03
69–	14·04	143·16
70–	14·54	147·34
71–	15·27	151·59
72–	16·06	155·29
73–	16·40	158·82
74–	16·54	162·35
75–	16·50	166·27

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The increase in standard deviation is about ·12 lb. for every pound increase in weight. Fig. 3 shows these values plotted together with the residuals at each age from Table 5. Each of the latter considered by itself is reasonably near to the values laid down by the table above, within the sampling limits, although taken together they may consitute evidence for an increasing standard deviation

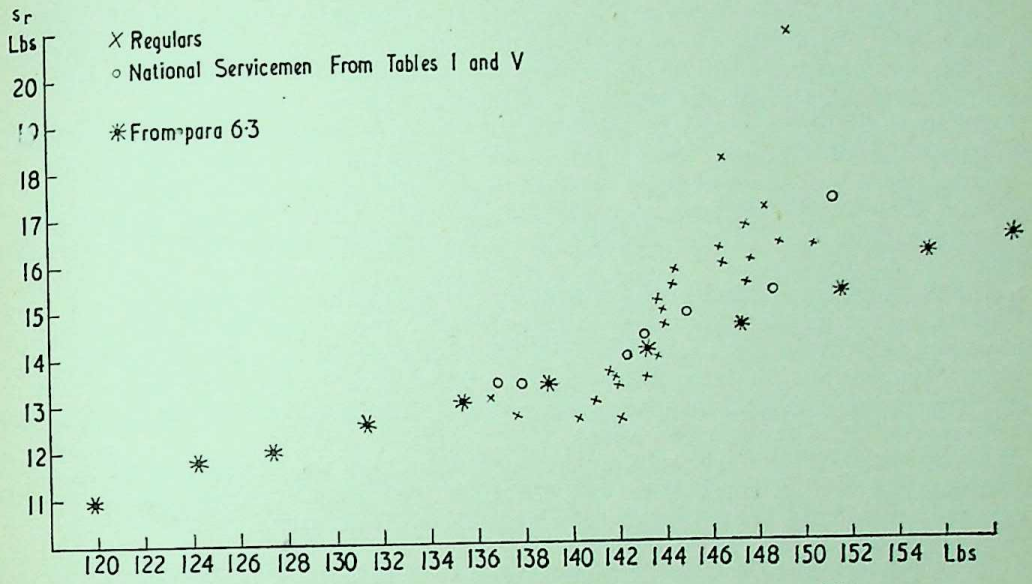


FIG. 3.—Residual standard deviations plotted against average weights.

TABLE 6

Born	Average Weights Adjusted to a Height of 67⅞ in.		Average Heights Adjusted to a Weight of 140 lb.	
	Regulars (lb.)	National Servicemen (lb.)	Regulars (in.)	National Servicemen (in.)
1902–1910*	149·40	—	66·91	—
1911	152·42	—	66·17	—
1912	149·82	—	66·91	—
1913	147·91	—	66·93	—
1914	149·71	—	66·61	—
1915	147·38	—	66·67	—
1916	148·89	—	67·35	—
1917	147·80	—	66·95	—
1918	148·45	—	66·99	—
1919	148·40	—	66·96	—
1920	144·05	—	67·49	—
1921	145·93	—	67·08	—
1922	147·04	—	67·14	—
1923	144·99	—	67·25	—
1924	145·07	—	67·17	—
1925	144·98	—	67·21	—
1926	142·76	—	67·47	—
1927	142·71	146·48	67·44	68·13
1928	143·31	144·03	67·56	68·31
1929	142·76	143·33	67·50	67·85
1930	142·03	142·14	67·71	67·85
1931	140·85	141·44	67·83	67·89
1932	139·93	138·25	67·94	67·97
1933	137·79	137·39	68·06	68·03
1934	137·26	—	68·01	—

* Mean year is at 1908.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with age, irrespective of weight. Once again the residual variation not accounted for by the regression line is slightly larger than the average value above. (This says no more than the non-linearity argument in para. 5.2.)

Changes Associated with Year of Birth Alone

7.1. In Table 6, the average weights at each age are adjusted to a constant height of $67\frac{7}{8}$ in. (i.e., $67\frac{1}{2}$ in. plus $\frac{3}{8}$ in.), using a regression slope of 3·8 lb. to the inch. Also the average heights are adjusted to a constant weight of 140 lb., using a regression slope of ·09 in. to the pound. We shall see later that this reduces the variation in changes over time.

It was noticeable before adjustment that the deferred National Servicemen were taller and heavier than Regulars of the same age. Now it is seen that the extra weight is almost all accounted for by tallness, that is to say men of equal height in the two groups weigh about the same. On the other hand, for a fixed weight the average deferred National Serviceman is taller than the average Regular of the same age. In other words, height is the important discriminator between the two groups.

7.2. For the purpose of examining the change in time (or rather with year of birth) of weight and height, we confine our attention to Regulars between twenty and forty years old, since at eighteen and nineteen the growth is more rapid. Remembering the difficulties in interpreting the younger age-groups, we can do no better than hazard that from the age of eighteen to nineteen, weight is increasing at about $2\frac{1}{2}$ lb. a year, from nineteen to twenty at about 1 lb. a year, and thereafter (as we now show) at about $\frac{1}{2}$ lb. a year.

What we now do in short is to measure the average change of weight and height, both for the original data of Table 1 and the adjusted data of Table 6. We also do this separately for the over-thirties and under-thirties to see whether there is any fall-off in the rate of gain.

		Unadjusted		*Adjusted*	
	*Born**	*Gain with Year of Birth*	*Residual Variance*	*Gain with Year of Birth*	*Residual Variance*
Weight:		*(lb.)*		*(lb.)*	
	1911–1921	−0·36	3·6114	−0·51	1·9870
	1921–1931	−0·39	0·8637	−0·53	0·4832
	1911–1931	−0·39	2·1030	−0·46	1·2218
Height:		*(in.)*		*(in.)*	
	1911–1921	0·040	0·1284	0·073	0·0762
	1921–1931	0·036	0·0121	0·072	0·0061
	1911–1931	0·020	0·0711	0·055	0·0436

* As elsewhere in this paper, standard errors of estimates are not given explicitly since they can easily be deduced from the data, e.g., in Table 1, n is given at each year of birth, and in Table 5 standard deviations, enabling if desired the standard errors of the means of Table 1, or the regression coefficients of Table 4, to be computed. Similarly in the tables above the residual variance need only be divided by 110 to obtain the variance of the regression coefficient for an eleven-year period and by 770 for a twenty-one-year period.

There appears to be no advantage in measuring a separate rate for those in their twenties and thirties. The adjustments to standard height and weight noticeably reduce the residual variances. (The accentuation of regression slopes after adjustment was to be expected with the signs being different for weight and height.)

In round figures, over twenty years the actual gain in weight is 8 lb. and fall in height $\frac{1}{2}$ in., while for equal heights the gain is 9 lb., and for equal weights the fall in height is 1 in.

7.3. The adjustments made to standard height and weight have been based so far on a relationship found within age-groups, or making no distinction between age-groups (see Table 4). If the mean heights and weights of Table 1 are plotted they show no clear relationship, since of course the age effect works in a contrary direction. It should be possible by the use of partial regressions to confirm the relationships already established, so long as they are fairly consistent from one year

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to another, and in fact the following are the results of calculating the partial regressions. The standard errors of the estimates are also given.

(*a*) Partial regression coefficients, using the mean heights and weights of Table 1:

Born	n	*Wt. on Ht.* (*lb. per in.*)	*Wt. on Year of Birth* (*lb. per year*)
1911–1921	11	3·57±1·39	−0·50±0·15
1921–1931	11	5·91±2·13	−0·60±0·10
1911–1931	21	3·53±0·99	−0·45±0·05

		Ht. on Wt. (*in. per lb.*)	*Ht. on Year of Birth* (*in. per year*)
1911–1921	11	0·127±0·049	0·086±0·032
1921–1931	11	0·083±0·030	0·068±0·014
1911–1931	21	0·119±0·033	0·066±0·015

Within the sampling limits, these correspond very well with the values already obtained.

(*b*) Partial regression coefficients, using original data:

Born	n	*Wt. on Ht.* (*lb. per in.*)	*Wt. on Year of Birth* (*lb. per year*)
1911–1921	1299	3·97±0·17	−0·54±0·15
1921–1931	5960	3·77±0·07	−0·52±0·06
1911–1931	7015	3·79±0·06	−0·47±0·04

		Ht. on Wt. (*in. per lb.*)	*Ht. on Year of Birth* (*in. per year*)
1911–1921	1299	0·074±0·003	0·057±0·021
1921–1931	5960	0·092±0·002	0·075±0·009
1911–1931	7015	0·088±0·002	0·056±0·006

These again agree with the previous results. They are naturally a closer fit than (*a*), because the weight-height estimates come mainly from within the age-groups.

Standard Tables

8.1. The most useful of standard tables is that showing average weights to be expected for different ages and heights. We produce one valid for 1951 (Table 7), with the proviso that differences between ages some way apart are not necessarily the actual gains in weight expected over the same period of years. As was pointed out in para. 3.3, there is a six-pound difference in weight between two groups whose ages are twelve years apart, yet the same generation had gained twice as much in twelve years' growth. The regressions used are 3·8 lb. to the inch, and ·46 lb. to each year of birth, within the ages twenty to forty years, and the heights 62 in. to 74 in. At age nineteen, the standards are reduced by 1 lb. from those at twenty, and by a further 2½ lb. at age eighteen. These values agree very well with the actual measurements in the series (Table 8). Note that Table 8 uses height groups such as 67–in., whereas Table 7 uses central values. There is a difference of ⅜ in.

8.2. At extremes of height, the regressions are no longer valid. We have little information at these extremes, and may summarize as follows. Table 3 gives the figures for 18-year-olds, and

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 7

Standard Weights (*lb.*)

Height (*central values*)	*Age*: 18	19	20	21	22	23	24	25	26	27	28	29	20	31	32	33	34	35	36	37	38	39	40
61 in. and under	113	115	116	117	117	118	118	118	119	119	120	120	121	121	122	122	123	123	123	124	124	125	125
62	116	118	119	120	120	121	121	121	122	122	123	123	124	124	125	125	126	126	126	127	127	128	128
63	119	122	123	123	124	124	125	125	126	126	127	127	128	128	128	129	129	130	130	131	131	132	132
64	123	126	127	127	128	128	129	129	129	130	130	131	131	132	132	133	133	134	134	135	135	135	136
65	127	130	131	131	131	132	132	133	133	134	134	135	135	136	136	137	137	137	138	138	139	139	140
66	131	133	134	135	135	136	136	137	137	138	138	138	139	139	140	140	141	141	142	142	143	143	144
67	135	137	138	139	139	140	140	140	141	141	142	142	143	143	144	144	145	145	145	146	146	147	147
68	138	141	142	142	143	143	144	144	145	145	146	146	147	147	147	148	148	149	149	150	150	151	151
69	142	145	146	146	147	147	148	148	148	149	149	150	150	151	151	152	152	153	153	154	154	154	155
70	146	149	150	150	150	151	151	152	152	153	153	154	154	155	155	156	156	156	157	157	158	158	159
71	150	152	153	154	154	155	155	156	156	157	157	157	158	158	159	159	160	160	161	161	162	162	163
72	154	156	157	158	158	159	159	159	160	160	161	161	162	162	163	163	164	164	164	165	165	166	166
73	157	160	161	161	162	162	163	163	164	164	165	165	166	166	166	167	167	168	168	169	169	170	170
74	161	164	165	165	166	166	167	167	167	168	168	169	169	170	170	171	171	172	172	173	173	173	174
75 and over	165	168	169	169	169	170	170	171	171	172	172	173	173	174	174	175	175	175	176	176	177	177	178

Note.—(1) The table is least reliable in the first and last lines; (2) the standard deviation is about 10 per cent. at each value (see para. 6); (3) the deciles are about 12½ per cent. on either side at each value (see para. 4), but quantiles of a higher order are increasingly larger at the upper than at the lower end.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 8

Actual Mean Weights in Lb. where Sample Sizes are over 20

Height Group		*Born:* 1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
60 in.	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	117	115	113	—
61–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	116	—
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	120	120	121	114	113	—
62–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	121	116	120
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	127	120	122	117	116	—
63–	Reg.	—	—	—	—	—	—	—	—	129	—	127	126	125	—	127	123	123	121	119
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	128	125	124	121	120	—
64–	Reg.	—	—	—	—	129	134	—	130	135	134	129	129	128	132	130	126	127	124	124
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	131	130	128	125	124	—
65–	Reg.	—	—	—	—	—	135	136	136	136	139	135	135	132	135	131	130	131	128	128
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	135	133	132	128	128	—
66–	Reg.	—	—	142	143	143	140	137	138	140	136	135	136	137	136	138	135	133	132	132
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	138	137	136	135	132	131	—
67–	Reg.	—	—	—	147	143	141	146	142	142	141	140	140	142	141	139	139	136	136	136
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	143	141	140	139	136	135	—
68–	Reg.	144	—	147	—	147	150	153	145	145	149	146	144	144	143	144	145	141	139	139
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	150	145	144	143	140	139	—
69–	Reg.	152	—	—	—	150	156	150	151	150	152	148	152	149	148	147	146	146	144	143
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	146	149	147	147	144	143	—
70–	Reg.	—	—	—	—	154	—	154	157	152	153	153	149	151	152	151	151	150	147	144
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	152	153	152	152	148	147	—
71–	Reg.	—	—	—	—	—	—	—	156	—	—	155	156	165	156	156	153	154	150	152
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	157	157	156	154	152	152	
72–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	161	158	157	161	159	155	155
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	160	160	159	156	155	—
73–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	164	160	—
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	165	163	165	159	159	—
74–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	168	165	—
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	169	168	166	162	162	—
75–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	171	—
	N.S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	165	170	169	166	—
76–	Reg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	N S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	174	—	171	168	

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

for the group aged twenty to forty that we have been analysing (average age about twenty-five) the corresponding weights are:

In.	*Av. Wt. (lb.)*	n
60 and under	121·67	33
61–	121·91	46
62–	122·43	139
63–	127·00	258
64–	131·24	522
65–	134·82	724
66–	137·61	916
67–	141·44	1,087
68–	145·83	1,013
69–	149·30	850
70–	152·77	607
71–	158·33	418
72–	162·29	227
73–	167·37	102
74–	170·77	43
75 and over	165·63	30
		7,015

Because of the smaller numbers, this table is not reliable at the ends.

Table 3 suggests that the linear relation of weight on height could be continued to a height of 75 in., and that weight should be left constant thereafter. At the other end we might reduce the standard by 3 lb. at 61 in. and leave it constant after that. Table 7 is augmented in consequence, although there is no real evidence that the linear law operates to a height of 75 in. for the higher ages (Table 3 is for eighteen-year-olds).

In the notes to Table 7, rough working rules are proposed that summarize the distribution of weights.

Effect of Initial Training

9.1. It is of interest to consider a sample of 845 National Servicemen, to see what effect their initial training had on their heights and weights. The measurements were taken on the same men on three occasions; at the Ministry of Labour examination on registration, at the time of call-up, and at the end of initial training. The sample was randomly selected from among all National Servicemen serving in 1952 and was mainly composed of 18-year-olds.

The average heights and weights and time intervals were as follows:

Ministry of Labour	*Call-up*	*After Training*
67·55 in.	67·56 in.	67·62 in.
136·11 lb.	136·65 lb.	139·50 lb.
	7·60 weeks	12·72 weeks

The height and weight at call-up agree very well with the figures already given in this paper.

The rates of gain before and after call-up were ·92 lb. in 3 months, and 2·91 lb. in 3 months respectively. The "natural" rate of gain is therefore about 3½ lb. a year before call-up, that is in the quarter-year immediately after the eighteenth birthday. This is in general agreement with the assumption of para. 7.2, that the average is 2½ lb. for the whole of the nineteenth year, since the rate of gain is continually decreasing.

Summary

10.1. Height and weight measurements of recruits to the Army during 1951 are analysed, giving a base-line from which similar measurements in the future can take their comparisons. For various reasons, there are few series in the past against which the present one can be matched, the most satisfactory relating to 1939. In comparison with that year, the average young man of 20 appears in 1951 to be about 6 lb. heavier and ½ in. taller, and to attain his maximum height

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

earlier. Furthermore that same pre-war generation gained an average of 12 lb. in weight over the 12 years.

10.2. While height and weight are closely related apart from the question of age, the heaviest of the 18-year-olds average a little under six feet in height, and the really tall ones average about twelve stone in weight.

As far as age is concerned, there is a steady gain in weight and loss in height over the groups from 20 years old to 40 years old, amounting to 8 lb. and $\frac{1}{2}$ in.

10.3. Increasing variability with age and weight is discussed, and the use of linear regressions to standardize comparisons.

10.4. During the period of initial training in the Army, the average gain in weight is at three or four times the "natural" rate.

References

KEMSLEY, W. F. F. (1950), "Weight and height of a population in 1943". *Annals of Eugenics*, **15**. 161–183.
MARTIN, W. J. (1949), "The Physique of young adult males". *Medical Research Council Memorandum*, No. 20.
MORANT, G. M. (1948), "Heights and weights of German civilians in 1946–7 and R.A.F. and other British series". *Biometrika*, 35. 368-396.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

The Statistics of Education

By Doris M. Lee

There is a large amount of statistical material relating to educational matters. This provides a wealth of basic data of interest to workers concerned with somewhat broader issues, as well as to students in the field of education. Available material can be divided into two main groups. The first covers the collection of such administrative data as numbers of schools, scholars, teachers and school meals; the second relates to the study of rather different problems lying within the fields of educational psychology and sociology. Each is sufficiently distinct to be worthy of independent consideration, though either may from time to time require the use of material belonging to the other type. Administrative statistics in education aim to set forth a numerical picture which illuminates and clarifies the situation under discussion, which presents material accounting for or resulting from certain pre-organized measures or expenditure, and which permits as far as possible of suitable comparative measures from region to region and from year to year, though the latter consideration of sequence in time must usually be regarded as subservient to the others. Scrutiny of such material reveals little more than the use of elementary statistical techniques, for the skill of the administrative worker lies in his ability to select, tabulate, classify and analyse his material in the manner best suited to the problem in hand. Such work tends to be encompassed with difficulties consequent upon variations of terminology, background and educational structure from area to area. For this reason, tables of administrative statistics are always accompanied by explanatory notes, and full value and understanding can only be achieved by studying the tables in the light of such notes and the corresponding educational situation. Statistical data concerning problems in educational psychology or sociology include some uses of the more complex statistical techniques, and such a tendency is in line with advances in the fields of the biological and agricultural sciences. In this setting the worker has greater scope in planning his research for an optimum use of suitable statistical techniques. His art lies in maintaining that duality between educational aspects and statistical techniques in which each renders the maximum contribution to the outcome of the investigation as a whole. Again the statistical material should be examined in the light of its educational context, for the use of statistical method is here an aid, and cannot do more than confirm or negate a given hypothesis.

The following information and references are given concerning the main types of material described above. The order of arrangement follows the administrative pattern of the educational systems. Central responsibility for national education lies with the respective government departments. In earlier years in Great Britain, these were successively the Committee of Council on Education (1839), the Education Department (1856), and the Board of Education (1899), although, until the latter organ was instituted, the Science and Art Department and the Charity Commissioners also shared in the administrative functions of education beyond the elementary level. The Scottish Education Department was first set up in 1872, and a separate Board of National Education for Northern Ireland was formed in 1922. In the most recent developments, the departments for England and Wales and for Northern Ireland have become Ministries of Education. Within this central historical framework were the School Boards, later superseded by the local education authorities whose areas of function are the counties and county boroughs of Great Britain. A county borough is a town or city accorded powers similar to those possessed by a county in respect of education and other services. In large counties, certain powers are entrusted to some non-county boroughs (known as excepted districts), to divisional executives, and to district sub-committees controlled by the main education committee. Outside this framework of national education, university finances and interests are in the main controlled by the University Grants

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Committee, a Treasury Sub-Committee not under the jurisdiction of the central departments for education. Originally the universities were within the province of the Board of Education, but later responsibility for finances and development passed to the University Grants Committee (England, Wales, Scotland), and to the Ministry of Education for Northern Ireland (Northern Ireland). Training colleges remain under the aegis of the ministry or department concerned, though most are also attached to the universities through the area training organizations. Thus each college is a member of a group of colleges centred around and affiliated to a university through the University Department of Education. The various bodies responsible for the system of external school examinations also operate in conjunction with the universities concerned. Working alongside the official bodies are many voluntary and professional organizations, such as the National Institute for Adult Education, the National Union of Teachers, the Associations of Assistant Masters and Mistresses, and the National Association for Mental Health. Administrative statistics of education are in some way the concern of all these bodies, though educational research is directly the concern of none. The two national bodies for educational research are the Scottish Council for Research in Education and the National Foundation for Educational Research in England and Wales, each of which can organize investigations on a national scale. The other main contributions to educational research are from individuals in university departments of education of the inspectorate, either working in conjunction with local education authorities or in direct association with the schools themselves. In a consideration of material relating to any aspect of British education, a related question arises as to how far national statistics from Great Britain are comparable with similar material from other countries. Consideration of this aspect of statistical work is helped by reference to the various *Year Books of Education* published in this country and elsewhere, and to the publications of the relevant UNESCO committees. Statistical material from the above sources is presented under the following headings :

I. Statistics of Educational Administration.
   (*a*) Government Departments.
   (*b*) Local Education Authorities.
   (*c*) Training Colleges and School Examinations.
   (*d*) Universities and University Colleges.
   (*e*) Difficulties in the Collection of Statistics of Educational Administration.
   (*f*) Voluntary and Professional Bodies for Education.
II. Statistics of Educational Research.
III. International Aspects of Educational Statistics.

I. *Statistics of Educational Administration.*

(*a*) *Government Departments*

Official reports (1) of the various parliamentary bodies for education have contained a wealth of statistical information ever since their inception in 1840. Such reports have been presented annually with the exception of the periods of the two World Wars (1914–19; 1939–46), and the year 1923–24, when economy measures prevailed. Originally the statistical material took an incidental place, but after a very few years a statistical section was formed. In 1901 it was decided to publish a separate volume of statistics, but in 1926 the statistical material was again included in the main report, and it forms Part II of this volume at the present time. Those who glance through this century of educational reports will find much to repay them. At once it is clear that the decision to publish the statistical material in a separate volume was necessitated by a vast growth of material with which suitable methods of classification had not kept pace. The early statistical material is almost entirely recorded by individual source, for example, where the table concerns grants to schools, each school and every relevant detail is listed separately, as in Table 1. As the complexity of the educational pattern increased, such tables ran into many pages, and gradually information was grouped under more general headings. Perhaps earliest and most interesting of these grouped tables was the presentation of information according to the religious denominations responsible for the schools, as in Table 2. With the creation of the school boards, later local education authorities, there arose a further useful administrative classification by geographical areas represented by these authorities. This classification fitted the expanding educational system

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 1

Statistics of Applications for Aid from Parliamentary Grants in 1842–43

Date of Receipt of Application	*Object of Application*		*Description of School*	*Number of Trustees under Several Heads*							*Extent of*		*Population of District from which Children will Assemble*	*Etc.*
	To Obtain Aid in	*At*		*Clergy or Ministers*	*Gentry*	*Professional Men*	*Merchants and Manufacturers*	*Farmers*	*Shop-keepers*	*Working-men*	*Site*	*Play-ground*		
1842, Jan. 1st .	The erection of a schoolhouse	Evesham	N	3	6	–	–	–	–	–	650 sq. yd.	A green about two acres	4,500	Etc.
1843, Apr. 3rd .	Do.	Brading	N	3	3	and two churchwardens					62×32 ft.	120×63 ft.	1,866	Etc.
	Etc.	Etc.	Etc.	———			Etc.			———	Etc.	Etc.	Etc.	Etc.

TABLE 3

Other Schools and Classes for Further Education. Statistics for the School Year Ending July 31*st*, 1907, *arranged under Local Education Authorities*

Reference Number	*Local Education Authority (County Council or Borough Councils)*	*Number of Schools and Classes*	*Number of Teachers*		*Number of Students, who attended, at any time during the School Year, and Number on account of whom Grants were Paid*										*Etc.*
					Boys and Men					*Girls and Women*					
			M.	*W.*	*12–15*	*15–18*	*18–21*	*21 and over*	*Total*	*12–15*	*15–18*	*18–21*	*21 and over*	*Total*	*Total*	*Etc.*
1	Bedfordshire (the Administrative County of Bedford)	66	116	55	536	888	420	436	2,280	215	421	302	632	1,570	3,850	
					430	*689*	*291*	*311*	*1,721*	*187*	*334*	*237*	*431*	*1,189*	*2,910*	Etc.
Etc.	Etc.	Etc.	Etc.	Etc.	———					Etc.						Etc.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Scholars on the Registers, 1888–89

Denominations	*Under 3*	*3 and under 4*	*4 and under 5*	—	*13 and under 14*	*14 and over*	*Total*
Schools connected with the National Society or with the Church of England	3,849	63,416	145,096	—	67,565	19,327	2,162,441
Welseyan Schools	195	4,561	10,886	—	6,377	1,914	174,336
Roman Catholic Schools	98	9,114	20,147	—	6,878	1,577	249,125
British, Undenominational and other Schools	516	8,427	19,886	—	12,686	4,329	331,438
School Board Schools	2,113	48,988	114,794	—	61,849	16,833	1,796,686
Total	6,771	134,506	310,809	—	155,355	43,980	4,714,026

so well that it quickly superseded the earlier grouping by denominations. An example is shown in Table 3. This method of classifying data by areas under local education authorities is still in use, but from 1926 onwards the bulk of the statistical information given in the reports of the separate boards (now ministries) of education in England and Wales and in Northern Ireland, and of the Scottish Education Department, is classified under somewhat less individual headings, such as types of school, thus giving only a very general picture of education over the country as a whole. An example of this more general classification is set out in Table 4. Thus, in the century

TABLE 4

Number of Grant-Aided Schools or Departments and other Schools Recognized as Efficient, January, 1952, *by Type, and the Number of Pupils and Teachers*

Grant-aided Schools Maintained by Local Education Authorities	*Schools or Departments*	*Pupils*		*Teachers*	
		Boys	*Girls*	*Men*	*Women*
Nursery	457	11,842	10,662	—	1,003
Infants	5,365	552,323	521,711	47	32,369
Junior with Infants	8,937	626,324	607,223	9,858	31,292
Etc.					

that has passed, published governmental statistics regarding England, Wales, Scotland and Northern Ireland have been transformed from an individual and human record to a rather general overall picture. Such a change has been an inevitable feature of the accompanying growth of education in these islands.

Within the gradual changes of classification described above, the arrangement of sets of tables has remained unaltered for several stretches of time. Early tables from 1840 are individual in character, having continuous stress on the needs of the period and being completely dependent for their existence on the correct surveys of H.M. Inspectors of Schools, for it was not until some years later that specific instructions on the collection of material were given. Tables of similar (and often identical) structure will be found from year to year during the periods 1869–1900, 1900–14, 1919–26, 1926–38, 1947–53, and in the latter cases differences lie more in the sectional arrangement of the tables than in the structure itself. Such material provides useful comparable evidence for several major aspects of educational administration. Throughout there can be formed data concerning numbers of schools and scholars, grants, teachers, training of teachers and buildings. In later sections, corresponding to their time of introduction into the educational field, there are tables concerning Teachers' Superannuation (1853), Further Education (1868), Special Schools (1885), Scholarships and Examination Successes (1855 for Training Colleges, 1920 for others), Health Service (1934), School Meals and Milk (1934), and Educational Building (1947). Some reports contain historical tables in which comparative information is given for a number of successive years. Of particular interest in this respect are the reports for the years 1920–21 and 1950; in the latter case, the comparative tables extend over the complete half-century. On the other hand, the function of compiling the more individual tables such as appear in the earlier reports has been delegated elsewhere. Tables of school activities and routine, items and details of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

expenditure under grants, costs of education per child, and similar tables have all become the prerogative of the local education authorities, the teachers' groups, or of the schools themselves. Other tables concerning such matters as school attendance in proportion to available population, fees, augmentation of teachers' salaries, have disappeared as the related problems have been solved. Certainly the critical reader may see the reflection of educational change in the historical evolution of the corresponding statistical tables.

The early reports of the Committee of Council on Education contain available information for England, Wales, Scotland and occasionally for Northern Ireland. The individual development and general increasing complexity of the educational patterns in these three separate areas of the United Kingdom led gradually to separate annual reports for Scotland (first, 1873–74), and for Northern Ireland (first, 1923–24). A separate report was issued for Wales during the years 1906–14 and 1919–22, but after 1922 tables for England and Wales were again incorporated in one volume. Figures are now given for England and Wales, and for Wales alone, so that figures for England can be obtained quickly by the reader. Three separate reports (2) are issued for the United Kingdom at the present time. These are concerned with public education in England and Wales, in Scotland, and in Northern Ireland, and each follows the same pattern, whereby Part I contains the report itself and Part II comprises the accompanying statistical tables. The tables attempt to give an overall picture of various aspects of education, and information of the following types will be found:

A. General Tables. Number of schools of different types; number of pupils and teachers by sex; number of pupils by age.
B. Further Information about Schools. Number of pupils in different types of schools by age and sex; pupils leaving schools, with age, reasons for leaving, and stage of progress; sizes of schools and classes; results of leaving certificate examinations.
C. Further Education Tables. Types of further education available; enrolments and courses; students by type, age and sex; analysis of students released by employers; examination results.
D. Teachers. By status, type of school, and by sex.
E. Training of Teachers. Students admitted to or completing courses of training within the year.
F. Teachers' Superannuation. Types of benefit awarded.
G. Building. Progress of building work by local education authorities.
H. Handicapped Children, Meals and Milk. Types of special schools; children by type of handicap, age and sex; numbers of children taking school meals and milk.
I. Scholarship Awards. Local education authorities; ministry or department for education; some analysis of students by university course and sex.
J. Finance. Summary of expenditure (Ministry of Education Services) of local education authorities.

Information under these sections is given in varying detail in the three reports, and such information may be contained in either one or several tables. The data are based on schools maintained by local education authorities, on direct grant schools and on recognized independent schools, but no figures are available for independent schools which are not recognized as efficient by the Ministry or Department of Education. Methods of classification are very similar usually involving some combination of type, status, denomination, area, age or sex, though each report expresses the individual pattern of the country with which it is concerned, and hence some differences in presentation and amount of detail are to be expected. Supplementary detail will also be found in the different sections of the separate reports. The report for Scotland, for example, gives some details of approved schools, since in Scotland approved schools come under the Department of Education, whereas in the other countries of the United Kingdom they fall within the scope of the Home Office. Again, Section B on schools (above) naturally reflects the educational system of the country concerned, and is inevitably couched in terminology consequent upon that system. For example, the report for England and Wales contains information for "Independent Schools Recognized as Efficient under Rules 16" and has no information about other independent schools, but this is a division relating to England and Wales only, and there is no counterpart in the other reports. Further, in connection with teachers, the categories of "primary" and "secondary"

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

divide at the class-age of twelve in Scotland, but at the eleven-year age-level in England and Wales. Three types of further education are employed in the tables for England and Wales, but only two occur in the tables for Scotland, part-time day and evening students being merged in the latter case. Such differences as this are apt to be misleading, since nothing can be deduced about individual categories when two are fused together. Finally, note must be taken of a very useful table which appears at the end of the report of the Scottish Department. This presents "Selected National Statistics Relating to Public Education according to Education Areas," and the form of the table permits many facts and comparisons to be obtained at a glance, thus offering a valuable general picture of the areas in relation to one another and to the country as a whole. This table has no counterpart in the reports for England and Wales and for Northern Ireland. These and other similar differences are not all apparent from a survey of the tables presented in the relevant reports, unless the numerical tables are studied in the light of the definitions, structure and terminology pertaining to the corresponding educational system. A further difficulty may be raised by the times of collection of the data, which in one case may take place on December 31st and in another on March 31st. Tables with dual classifications such as age and sex, or type of school and sex, should also be used with care, since certain combinations of classifications may render impossible the extraction of comparable data. In short, close scrutiny of terminology, mode of classification, and time of collection of data, is necessary when examining similar tables for these three countries, in order to ensure that the separate tables yield valid comparable material.

Explanatory material for the statistical tables described above is to be found in Part I of the corresponding report. In the text of Part I will also be found many references to other publications of the various ministries or departments of the United Kingdom, and of other related organizations. A reader wishing to consult statistical material on a given aspect of education will do well to investigate relevant references. He will frequently discover that use has been made of the statistical material in the main report, and that further amplification of such material is given. The degree of amplification varies considerably with the problem and with the facilities accorded to those who are responsible for the acquisition of material. Some types of data are essentially the responsibility of ministeries or departments other than education (3), and these allied reports supply valuable information for workers in the educational field. The reports of the School Health Service, for example, are a separate concern of the Ministry of Education for England and Wales, but come under the Departments of Public Health in Scotland and in Northern Ireland. These reports offer some amplification of the small sections in the main education reports. In the case of England, Wales and Scotland, Part IV of the Civil Estimates gives an analysis of the allotment of the parliamentary grant for education, including the award of university grants and the upkeep of various museums. Some financial statistics are given for Northern Ireland in a section of the *Ulster Yearbook*, and a further section on education sets out some tables which are complementary to those in the main education report, each of these sections being accompanied by a most useful bibliography for reference purposes. Amongst the multiplicity of other related documents facing the visitor to Her Majesty's Stationery Offices, many will be found to contain nothing beyond the statistical tables of the main reports. Here attention should be drawn to the publications of the various advisory councils on education, in which useful discussions of material and further references are frequently given. The sources of this type of material are identical with, or similar to, those of the main education reports, and hence the material will again give a general picture. With regard to the main education reports, the tables relating to schools, further education and finance are obtained chiefly from returns made by local education authorities, and hence can reveal nothing of the nature of the schools or of the individual children who compose the population. The other tables are compiled from rather more individual information which may also be available in local education areas. As already noted, comparable figures for the separate local education authorities are published by the Scottish Education Department, and material of this kind may be available for England and Wales and Northern Ireland in an unpublished form. In England and Wales, comparable material for the separate local education authorities is duplicated by the Mnistry of Education Statistics Office, and on occasion this is circulated to the authorities for their use and information. Similar data on a basis of school divisions may also be obtained, for yearly returns from each school cover "the number of full-time pupils on the register of each class or form on the first day in January on which the school or department was open, classified by age on that date, and particulars of the teachers employed." Although the published statistics of public education

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

seem to relate solely to the respective countries as a whole, it is thus apparent that information relating to the various areas and schools does also exist. At the same time it should be noted that such material is capable of no further analysis, and does not relate to individual children. Before the Second World War, the Ministry of Education in England and Wales used Hollerith cards to map the progress of each child in every grant-aided secondary school. This procedure is now discontinued. An analysis of basic material of the above types might, in certain circumstances, be available to an accredited research worker upon a previous written application to the ministry concerned. In the case of the Ministry of Education in England and Wales, such available material includes sets of IBM cards relating to some of the topics for which tables are given in the annual reports.

(b) *Local Education Authorities*

In addition to providing much basic data for the annual reports of the respective central bodies for education, many Local Education Authorities publish separate reports (4) for the areas under their control. Such reports tend to resemble those of the central bodies, though in this instance the unit for collection of data is the district education office, the divisional executive, or the school itself. Few local education authorities publish an annual report; a three, five or ten-year comparative study is more frequently found. Many authorities published no reports during the Second World War. Material similar in form to that of the main ministry reports is usually included in the local education authority reports, though evidently relevant to the one area only, and occasionally the date of collection of the statistics is different. New material is frequently included, such as details of universities or colleges within the area, and reference to county library schemes. Some educational statistics may also be found in more general volumes issued concerning the activities of the county council, and details of estimates and expenditure can usually be seen in the Estimates and Accounts of the County Council. This material is normally available for consultation in the public libraries of the relevant area. Some statistics relating to training colleges may also be obtainable through a local education authority, in the circumstances under which the training college lies within the jurisdiction of the authority. Additional material, such as numbers of children in receipt of clothing grants, is often available only in division or district offices, and statistics concerned with individual children must be obtained from the schools themselves. Written application to obtain and use any such statistics or any unpublished statistics, whatever the form, should in the first instance be made to the chief education officer of the authority concerned. An accredited research worker can then be given expert assistance and guidance as well as permission to seek out his material. In addition to the separate reports of the local education authorities, some comparable material has been set out in the leaflet "Education Statistics, 1951–52", published jointly by the Institute of Municipal Treasurers and Accountants (Incorporated) and the Society of County Treasurers (5). This publication gives comparative figures for all the counties and county boroughs in England and Wales for such topics as numbers of pupils on school registers, numbers of full-time teachers, total net expenditure chargeable to rates and grants, and the analysis of costs per pupil on registers. This document might well save much time for a worker interested in comparative statistics of this kind.

(c) *Training Colleges and School Examinations*

Certain of the tables contained in the annual reports of the Department and Ministries of Education in the United Kingdom depend for their basic data on sources other than local education authorities, and one sphere of Education lies wholly outside their scope. The few tables referring to training colleges depend for their information on the area training organizations centred round the university departments of education, or on the colleges themselves. For further amplification of these tables, or for help in obtaining information concerning other topics, such as examinations or more individual student profile statistics, written application should, in the first instance, be made to the Department or Ministry concerned. Area Training Organizations will probably prove as diverse in their available data and methods of collection as are local education authorities in the school sphere. Some unpublished statistics may be available from them, or suggestions given as to where the required material may be obtained. Similarly, further amplification of the tables concerning the school leaving certificate examinations would necessitate application to the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ministry or department concerned, or to the various university bodies which carry responsibility for these examinations. Here again, care is essential in making comparisons between data and results from different examinations. Conditions of entry, types of paper, pass levels and environmental influences all tend to vary, and any differences tend to vitiate comparisons.

(d) *Universities and University Colleges*

Universities and university colleges receiving grants direct from the Treasury lie outside the scope of the annual reports already described. In Great Britain such grants are controlled and administered on the recommendation of the University Grants Committee, and certain statistics relating to universities and university colleges may be found in the occasional (now quinquennial) reports and annual returns made by them to the Treasury, and presented to Parliament as Command Papers (6). This material was produced by the Board of Education during the period from 1894 to 1919; since that time the duty has been undertaken by the University Grants Committee, and the present form of the report and returns dates from 1922. Returns have been issued annually with the exception of the period 1939–47 covering the Second World War. The reports of the committee incorporate portions of statistical tables and graphs in the text; in the appendices there are some very general tables concerning numbers of full-time students, additional student places, academic staff, income and expenditure, recurrent grants, and salaries of the principal grades of academic staff. Rather more tables are given in the annual "Returns from Universities and University Colleges in Receipt of Treasury Grant". Any copy of these returns will give comparative statistics for the academic year just completed. These figures cover those university institutions receiving grants from the Treasury through the University Grants Committee, and the tables in the current returns (7) give the following types of information :

A. Students. Proportion of home and university residence amongst full-time students. Full-time graduating and diploma students entering for the first time in 1951–52. Numbers of students reading for degrees, diplomas, etc. Full-time students arranged under faculties and schools. Degrees and diplomas obtained, according to faculties and schools. Branches of study in which advanced students were engaged. Main subjects in which honours degrees were obtained.

B. Staffs. Numbers of full-time staffs employed in the teaching departments, arranged under various grades.

C. Finances. Income and expenditure of the various universities in Great Britain for the years 1950–51 and 1951–52. Summaries of income and expenditure for 1951–52 under several heads. Treasury grants to universities and university colleges, etc. Great Britain, paid on the recommendation of the University Grants Committee.

D. Libraries.

E. Nine interspersed tables dealing separately with the University of London (seven) and with the institutions comprised within the Universities of Durham, London and Wales (two). These tables embrace some more complex aspects of the former tables covering the universities of Great Britain as a whole.

Methods of classification are similar to those employed in the main education reports for Great Britain, though difficulties of terminology and differing dates of collection do not complicate the interpretation of these tables. The Queen's University of Belfast is not included, since it falls outside the aegis of the University Grants Committee in that its grants are obtained directly from the Treasury of Northern Ireland. Enquiries concerning statistics related to this and to other individual universities would best be made to the universities themselves. The Office of the University Grants Committee is pleased to render all assistance in its power to an accredited research worker, but the type of unpublished material available from them will certainly be related to the tables included in the report and returns. It will be readily appreciated that universities are complex organizations, and correct statistics relating to individual universities, and incapable of misinterpretation, will be most satisfactorily acquired with the expert help of the universities concerned. It is on this level that such problems of terminology as the definition of a full-time or part-time student become apparent. Few statistics are published by individual universities, but the research worker will find a readiness to co-operate in providing the necessary material for a particular study.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In this connection it should be taken into account that there is probably greater diversity in university patterns and procedures than in those of any other type of educational institution.

(e) *Difficulties in the Collection of Statistics of Educational Administration*

Some of the difficulties occurring in the collection of administrative statistics for comparative purposes have already been indicated. Similar difficulties arise in the collection of simple administrative statistics in any given area, whatever its size. In England and Wales, for example, the problem of correctly dividing the all-age schools for different statistical purposes is of long-standing occurrence. On the other hand, where the boundaries of primary and secondary or junior and infant schools are concerned, some ten-year or seven-year old classes occur in both types of school. Any method of assigning a class to a given age-category according to the majority age-group represented in that class allows the possibility of a wider age-range than that indicated by the category in which the class is placed. Thus such a division has no real relevance to the categories employed, and this renders the tabulation of classes by age both difficult and artificial. A major problem in the tabulation of any school statistics is the lack of data concerning independent schools. Some data are available for recognized independent schools, but very few for those which are not recognized. This is a serious shortcoming, since in these circumstances government and local authority tables can seldom present a complete picture concerning any aspect of school education. Any total picture of school education in Great Britain will involve some form of estimation for the missing data concerning independent schools which are not recognized as efficient. In another field, there are three annual estimates of the number of teachers under different categories, and the fact that these separate estimates can only with difficulty be brought to some form of agreement shows the diversity of interpretation which can be placed upon these categories. The tabulation of numbers of university students raises the problem of "double-counting", for where a student is registered in one university but takes part of his course elsewhere, some decision has to be taken as to where the effective "count" of that student shall be made. Again, in recording the numbers of new entrants to the universities, no account is taken of the undergraduate who has previously followed a different course in another university. Movements of such individuals blur the picture of the numbers of students entering universities for the first time. Efforts to solve these and similar problems frequently give rise to footnotes in the relevant tables, and these should be taken into account (and not just "noted") in reading the tables themselves. The difficult problem of estimating the school population in future years figures little in official reports, although it is of primary importance in deciding future policy with regard to buildings, teachers and other requirements. This is a considerable problem in estimation fraught with all the complications of a moving population not rigidly defined. Of all the problems facing the administrative worker, this is one of the most elusive and yet the most important in many issues. Amongst the problems of collecting administrative statistics, this question of estimation of school population stands little chance of solution by methods which may be characteristic in resolving the others.

(f) *Voluntary and Professional Bodies for Education*

Other information concerning schools, teachers, further education and related topics may become available from organizations outside the official administrative framework. Among such organizations are the National Union of Teachers, the Associations of Assistant Masters and Mistresses, and the National Institute for Adult Education. Such bodies sometimes collect statistical material concerning special problems in education. For example, a recent publication (8) of the National Union of Teachers gives considerable analysis of the methods used by Local Authorities in selecting children for different types of secondary education. From such sources figures relating to children in both types of independent schools might be obtained, for whereas no government body has power to collect data from some of these schools, a voluntary association might elicit a good deal of information for some special purpose.

II. *Statistics of Educational Research*

Side by side with the development of administrative statistics in education, there has been a continuous sequence of attempts to apply statistical method to other types of educational problems

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with a view to bringing a more scientific approach into their study. More than fifty years of such work in the field of educational psychology is contained in the volumes of the *Forum of Education* and the later *Journals of Educational and Statistical Psychology* published by the British Psychological Society (9). Some similar work in educational sociology is of much more recent date, and is chiefly available in thesis form. Foremost amongst early workers in the field of educational research was Sir Francis Galton, who attempted to apply newly discovered statistical ideas to data obtained from his observation and study of people (10). Subsequent developments of this scientific approach to the study of the human mind have led to much further work concerned with the assessment of human abilities, and, in particular, to the creation and development of the theories and methods of factorial analysis. Much of the earlier discussion in this field is reported in the volumes of the *Forum of Education*, and later work is contained in the journals of the British Psychological Society. The names of Burt (11) and Thomson (12) in Great Britain, and of Thurstone (13), in the United States of America, are associated with the more recent work. This technique of factorial analysis remains a centre of controversy between psychologist and statistician, since the rigorous statistical foundations are still incomplete (14). Other statistical investigations have centred round problems connected with the reliability of examinations, and the writings of Valentine & Emmet (15), and of Burt, Hartog and Rhodes (16), are of importance in this field. Present interest is directed more towards the question of selecting persons for different types of school or occupation, and much notable work has been done by individuals working in conjunction with local education authorities or by the administrative officers themselves. Contributions on record include the work of Thomson and Lambert (Northumberland), Burt (London), Valentine (Walsall), Alexander and Drew (Sheffield), Wiseman (Devon and Manchester), Peel (Durham and Grimsby), Dempster (Burton-on-Trent and Southampton), and Emmett (West Riding) (17). Techniques of selection are also of importance in industry (18) and in the armed forces (19), though work in this sphere is perhaps less in the public eye. These and allied problems have for nearly thirty years been the province of the Scottish Council for Research in Education, and some evidence of a statistical nature is contained in their publications (20). Of more recent date is the work of the National Foundation for Educational Research in England and Wales, and under its auspices some publications (21) have already appeared. Lone workers in the inspectorate and in university education departments have also contributed, amongst whom stand the names of Richardson, Burt, Hamley, Thomson, Schonell, Vernon, Peel and Peaker (22). Peaker has employed administrative statistics as a framework for research of another kind (23), thus providing an interesting link between two normally independent spheres of study. Theses of university graduates in Education (24) are too frequently models of statistical tidiness, and sometimes irrelevant to the needs and pressures of education itself.

Most of the known methods of statistical work are applied within these many records of quantitative approaches to psychological problems. Often the statistical techniques are of the most elementary nature, though some evidence of the use of Fisherian techniques and of the more complex experimental designs can be found. Burt (25) (in England) and Lindquist (26) (in the United States of America) were amongst the first to bring these methods beyond the field of agriculture. From their form, these advanced methods seem particularly appropriate to the study of educational problems, yet too often their value is impaired by some longstanding difficulties consequent upon inherent errors and uncertainties within the work itself. The human person is complex, and human nature and personality are in no sense totally measurable. External influences playing upon human beings are also impossible to control, for the whole sense of education and life is easily destroyed, or, at the least, diverted, when artificial experimental environments are set up. This particular difficulty renders the problem of experimental conditions and sampling so acute in the field of education that many workers have been tempted to pay little attention to them, and it is perhaps here that the statistical side of educational research is at its weakest. The Scottish Council for Research in Education has organized investigations on a national scale, thus taking the whole relevant child population as basis. The National Foundation for Educational Research in England and Wales and some individual workers have used a complete or partial local area as sample, thus working from a reasonably varied group. Many other workers, however, have collected data from such a small number of pupils or schools that their findings are biased in a manner which sometimes renders the results negligible in the wider educational field. Again, the difficulty of basic measurement detracts from the use of the more complex statistical techniques,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

for the errors of measurement may be so great that the finesse of the experiment is unwarranted, and the value of the conclusions is minimized. None the less, there exists much literature concerning the application of statistical methods in educational research, and those who turn the pages of the records may evaluate the methodology for themselves.

III. *International Aspects of Educational Statistics*

It remains to add a little information concerning comparative educational statistics for the United Kingdom and other countries of the world. On the side of educational research this is a simple matter. Problems and methods in this field are similar the world over, and the literature is easily exchangeable. Mention may be made of the work carried out in the United States of America, particularly in the laboratory of L. L. Thurstone (13) (for many years at the University of Chicago and now at the University of North Carolina) under E. F. Lindquist (26) at the University of Iowa, and under J. P. Guilford (27) in the University of Southern California at Los Angeles. Much material has also been published under the auspices of the Toronto Department of Educational Research, Canada, and under the South African, New Zealand, and Australian Councils of Educational Research (28). On the administrative side, the difficult problem of collating statistics of schools, scholars, teachers, colleges and universities in different countries of the world has recently been taken over by UNESCO, though efforts to produce comparative statistics of this kind were launched as far back as 1927. In 1946, UNESCO appointed a committee on educational statistics, and a questionnaire was prepared and sent to seventy-two countries with a view to collecting the maximum of basic data. The chief problems proved to be those of terminology, and methods of collection and tabulation of data, for these questions are inter-woven with the education system of the country concerned, and therefore may differ a good deal from one country to another. Hence methods by which statistics are collected nationally may not be applicable in the international field. A report of the committee of experts invited to work on these problems is available amongst recent UNESCO publications (29), and many of the data assembled from fifty-seven replies to the international questionnaire are now collated in the *World Handbook of Educational Organization and Statistics* published in 1952 (30). This book has an excellent introduction containing the history of experiments in collecting international educational statistics. There are also many useful references to other publications, amongst which are the *Year books of Education* and the *Year Book of the Associated Universities of the British Commonwealth*, all of which yield some material of an international nature (31). In addition, it is possible in many cases to procure statistical material for each country from the Ministry of Education or the Government Statistics Office concerned (32). In using this latter material, problems of terminology will inevitably interfere with valid comparisons, and it seems unlikely that such momentous and fundamental differences will ever be totally eradicated.

Acknowledgements

The writer would like to express her sincere thanks and appreciation to many people, in different fields of education, who have given freely of their time to help and advise in the construction of this paper, especially to the staffs of the Statistics Office and Library at the Ministry of Education, London, and to the Director and Fellow Colleagues at the University of London Institute of Education.

Bibliography

(1) Committee of Council on Education (1840–1873), Committee of Council on Education, England and Wales (1874–1899), Committee of Council on Education in Scotland (1874–1908), Scottish Education Department (1909–1953), Board of Education, England and Wales (1900–1944), Ministry of Education, England and Wales (1945–1953), Board of National Education, Northern Ireland (1922–1947), Ministry of Education, Northern Ireland (1948–1952). *Reports on Education*, published annually with the exception of the periods covering the two World Wars and the year 1923–24. H.M.S.O., Cmd. papers. Available at the Ministry of Education Library, London.

(2) Figures are drawn from:
Scottish Education Department (1953), *Education in Scotland*. Edinburgh: H.M.S.O., Cmd. 8813.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Government of Northern Ireland (1952), *Report of the Ministry of Education*, 1950–51. Belfast, H.M.S.O., Cmd. 313.
Ministry of Education, England and Wales (1953), *Education in* 1952. London: H.M.S.O., Cmd. 8835.

(3) Such publications as:
General Register Office (1854), *Census of Great Britain*, 1851; *Special Section on Education.* London: H.M.S.O.
Treasury (1953). *Civil Estimates for the Year ending* 31*st March*, 1954; *Education and Broadcasting*. London: H.M.S.O.
Central Statistical Office (1953), *Annual Abstract of Statistics; Section on Education.* London: H.M.S.O.
Ministry of Education, England and Wales (1952), *The Health of the School Child.* London: H.M.S.O.
Department of Health for Scotland (1952), *Reports of the Department of Health for Scotland and the Scottish Health Services Council; partial contents, School Health Service.* Edinburgh: H.M.S.O., Cmd. 8799.
Scottish Education Department; Advisory Council on Education in Scotland (1920–1953), *Reports on Spcial Educational Problems.* Edinburgh: H.M.S.O., Cmd. papers.
Board of Education, England and Wales; Consultative Committee. Ministry of Education, England and Wales; Central Advisory Council for Education (1900–1953), *Reports on Special Educational Problems.* London: H.M.S.O.

(4) Reports issued by Local Education Authorities, e.g., Kent Education Committee (1950), *Education in Kent*, 1938–48. Published by the Kent Education Committee, Springfield, Maidstone, Kent.
Essex Education Committee (1952), *Education in Essex*, 1945–52. Published by the Essex Education Committee, County Offices, Chelmsford, Essex.

(5) Institute of Municipal Treasurers and Accountants (Incorporated), and The Society of County Treasurers (1953), *Education Statistics*, 1951–52. Published jointly by the issuing bodies.

(6) Board of Education, England and Wales (1894–1914), *Annual Reports from University Colleges.* London: H.M.S.O., Cmd. papers.
University Grants Committee (1919–1953), *Reports and Annual Returns from Universities and University Colleges in Receipt of Treasury Grant.* London: H.M.S.O. Cmd. papers. Available in the Ministry of Education Library, London.

(7) Figures are drawn from:
University Grants Committee (1953), *University Development; Report on the Years* 1947 *to* 1952. *Returns from Universities and University Colleges in Receipt of Treasury Grant; Academic Year*, 1951–1952. London: H.M.S.O., Cmd. Papers 8875, 8847 respectively.

(8) National Union of Teachers (1949), *Transfer from Primary to Secondary Education.* Evans Bros., for the National Union of Teachers.

(9) Training Colleges Association (1923–1930), *Forum of Education.* Published by the Training Colleges Association. Vols. I–VIII.
British Psychological Society and Training Colleges Association (now Association of Teachers in Colleges and Departments of Education) (1931–1953), *British Journal of Educational Psychology.* Methuen & Co., Ltd. Vols. I–XXIII.
British Psychological Society (1948–1953), *British Journal of Statistical Psychology.* University of London Press, Ltd. Vols. I–VI.

(10) See, for example:
FLUGEL, J. C. (1948), *One Hundred Years of Psychology*, 1833–1933. London: Duckworth, Chapter III.

(11) BURT (Sir) C. (1940), *Factors of the Mind.* University of London Press, Ltd.

(12) THOMSON, (Sir) G. H. (1950), *The Factorial Analysis of Human Ability.* University of London Press, Ltd.

(13) THURSTONE, L. L. (1947), *Multiple Factor Analysis.* University of Chicago Press, Ltd.

(14) KENDALL, M. G., and BABINGTON SMITH, B. (1950), "Factor analysis", *Journal of the Royal Statistical Society*, Series B, Vol. XII, pp. 60–94.

(15) VALENTINE, C. W., and EMMETT, W. G. (1932), *The Reliability of Examinations.* University of London Press, Ltd.

(16) BURT (Sir) C., HARTOG (Sir) P. J., and RHODES, E. C. (1936), *The Marks of Examiners.* Macmillan & Co., Ltd.

(17) For further information, see under these names in journals under (9), or books by these authors, where available.

(18) National Institute of Industrial Psychology (1927–1953), *Occupational Psychology.* Published by the National Institute of Industrial Psychology. Vols. I–XXVII.
South African Council for Scientific and Industrial Research (1949–1952), *Bulletin.* Published by the South African Council for Scientific and Industrial Research. Vols. I–IV.

(19) VERNON, P. E., and PARRY, J. B. (1949), *Personnel Selection in the Armed Forces.* University of London Press, Ltd.

(20) Publications of the Scottish Council for Research in Education, particularly:
V. (1933), *The Intelligence of Scottish Children.*
VI. (1935), MACGREGOR, G., *Achievement Tests in the Primary School.*
XV. (1939), MACMEEKEN, A. H., *The Intelligence of a Representative Group of Scottish Children.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

XVI (1940), THOMSON (Sir) G. H., *An Analysis of Performance Test Scores of a Representative Group of Scottish Children.*
XIX. (1942), MCCLELLAND, W., *Selection for Secondary Education.*
XXX, with Population Investigation Committee (1949). *The Trend of Scottish Intelligence.*
Published by the University of London Press, Ltd.

(21) Publications of the National Foundation for Educational Research in England and Wales, particularly:
WATTS, A. F., and SLATER, P. (1950), *Allocation of Primary School Leavers to Courses of Secondary Education.*
WATTS, A. F., PIDGEON, D. A., and YATES, A. (1952), *Secondary School Entrance Examinations.*
Published by Newnes Educational Publishing Co., Ltd.

(22) For further information, see under these names in journals under (9), or books by these authors, where available.

(23) PEAKER, G. F. (1953), "A sampling design used by the Ministry of Education", *J. R. Statist. Soc.*, Series A, Vol. CXVI, Part II, pp. 140–165.

(24) National Foundation for Educational Research in England and Wales:
BLACKWELL, A. M. (1950), *A List of Researches in Education and Educational Psychology*, 1918–48. Newnes Educational Publishing Co., Ltd.
BLACKWELL, A. M. (1952), *A Second List of Researches in Education and Educational Psychology*, 1949–51. Newnes Educational Publishing Co., Ltd.

(25) BURT (Sir) C., and LEWIS, R. B. (1946), "Teaching backward readers", *British Journal of Educational Psychology*, Vol. XVI, pp. 116–132.
BURT (Sir) C. (1948), "A Comparison of factor analysis and analysis of variance", *British Journal of Statistical Psychology*, Vol. I, pp. 3–26.

(26) LINDQUIST, E. F. (1953), *Design and Analysis of Experiments in Psychology and Education.* Houghton Mifflin Company.

(27) GUILFORD, J. P. (1950), *Fundamental Statistics in Psychology and Education.* McGraw-Hill Book Company, Inc.

(28) Statistical material is to be found in the publications of the following Educational Research Organizations:
University of Toronto. Ontario College of Education. Department of Educational Research.
The South African Council for Educational and Social Research.
The New Zealand Council for Educational Research.
The Australian Council for Educational Research.

(29) UNESCO (1952), *Report of the Working Party on Educational Statistics.* Published by UNESCO.

(30) UNESCO (1952), *World Handbook on Educational Organization and Statistics.* Published by UNESCO.

(31) University of London Institute of Education (1932–1940; 1948–1952), *The Year Book of Education.* Evans Bros., Ltd., in association with the University of London Institute of Education.
University of London Institute of Education and the International Institute of Teachers College, Columbia University, New York (1953), *The Year Book of Education.* Evans Bros., Ltd., in association with the University of London Institute of Education and the International Institute of Teachers College, Columbia University, New York.
International Institute of Teachers College, Columbia University, New York (1924–1943), *The Educational Yearbook of the International Institute of Teachers College, Columbia University.* Bureau of Publications, Teachers College, Columbia University, New York.

(32) Examples of the types of available publications are:
Commonwealth Bureau of Census and Statistics, Canberra (1953), *Official Year Book of the Commonwealth of Australia.* Government Printer, Canberra.
Union Education Department (1947), *Bulletin of Educational Statistics for the Union of South Africa.* Government Printer, Pretoria.
Fondation Universitaire, Bureau de Statistiques Universitaires (1952), *Rapport Annuel*, 1952. Bureau de Statistiques Universitaires, Bruxelles.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

PAGE

1.—*Smith* (*C. A. B.*). The Principles of Mathematics for Students of Biological Science 361

2. *Latscha* (*R.*). Tests of Significance in a 2 × 2 Contingency Table: Extension of Finney's Table
   David (*F. N.*) & *Kendall* (*M. G.*). Table of Symmetric Functions. Part IV . 362
   Bickley (*W. G.*). Bessel Functions and Formulae

3.—*Bell* (*D. A.*). Statistical Methods in Electrical Engineering 362

4.—*Wolfenden* (*Hugh H.*). Population Statistics and their Compilation . . . 363

5.—*Ferber* (*R.*). A Study of Aggregate Consumption Functions 364

6.—*Gilbert* (*Milton*) & *Kravis* (*Irving B.*). An International Comparison of National Products and the Purchasing Power of Currencies 365

7.—*Burns* (*Arthur F.*). The Frontiers of Economic Knowledge 366

1.—*Biomathematics. The Principles of Mathematics for Students of Biological Science.* By C. A. B. Smith. London: Griffin, 1954. xv + 712 pp. 9″. 80*s*.

This is an excellent book. Dr. Smith has thoroughly revised and extended Feldman's *Biomathematics*, first published in 1923. The book starts from a knowledge of very elementary algebra and arithmetic and works through to the elements of partial differentiation, differential equations and multiple integrals and to the theory of vectors and matrices, ending with three chapters on probability and statistical theory.

The writing is clear, careful and readable, the mathematical ideas are admirably illustrated by a wide range of biological applications and there is a good collection of exercises and their solutions for the student. Although the book is very rightly free of formal proofs of the ε-type, Dr. Smith has been meticulous in ensuring a logical development of the subject. For example he has introduced logarithms from the properties of the equiangular spiral primarily in order to avoid the difficulty of defining from first principles a^b, for irrational b. I am not sure to what extent such subtlety will be appreciated by the readers for whom the book is intended, although Dr. Smith's account is certainly not open to criticism for lack of clarity. There are frequent short asides dealing with points, such as illogical notations, which puzzle the student. This makes the book particularly valuable for the reader working by himself.

Some minor criticisms may be made of the arrangement. The section on beta and gamma functions might be detached from the statistical section and brought into the part on integral calculus. The section on multiple integrals might be rather better there also, and the change of variables in such integrals might be dealt with a little more fully. The excellent chapter on Physical and Chemical Magnitudes, which includes formulae for calculating the day of the week on which the xth day of the yth month of 19uv falls, might usefully include a brief account of elastic constants.

In his preface the author says that the three statistical chapters are not to be considered as a text-book on statistics but rather as a brief introduction to the subject. Of the three chapters the first, called "Chance and Probability", contains excellent illustrations of the application of the laws of probability to genetics. The other two chapters are, in my opinion, a little too heavily biased towards genetical applications. For instance, correlation receives a lengthier treatment than regression and this is not a fair reflection of their relative importance outside genetics. Again there is a comparatively detailed account of the theory of efficient estimation which, despite its great theoretical importance, is probably not often of direct use to the biological research worker, outside genetics. Other topics which one would hope to find are not treated at all. Thus there is no account of the method for finding the asymptotic standard error of a function of observations from the dispersion of the observations themselves, even though the method occurs implicitly in the section on estimation; there is no mention of least-squares and only a very brief reference to the Poisson distribution. Nor is there a systematic account of how to choose a distribution rule to fit distributions of a given shape; it is often useful to know that positive quantities with positively skew distribution may be represented by log-normal or gamma-type curves, and so on. Of course the choice of subject matter in an introductory account is very much a matter of personal

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

choice but the topics just mentioned can be treated briefly at the mathematical level of the rest of the book, and are the sort of mathematical devices which the non-specialist can sometimes use in his own research work.

The book is attractively produced. It is a great pity that the price, while not excessive considering the size of the book, is too high for many students to be able to buy their own copies. The book can be very strongly recommended to anyone requiring either a systematic course of reading in mathematics at this level, or a reference book, and its use should by no means be restricted to those whose main interest is in biology.

D. R. Cox.

2.—*Tests of Significance in a* 2 × 2 *Contingency Table: Extension of Finney's Table.* Computed by R. Latscha. "Separate" no. XVII from *Biometrika* (1953) **40**, 74. London: Biometrika Office, [14 pp.]. 10¾″. 2*s.* 6*d.*

Tables of Symmetric Functions. Part IV. By F. N. David and M. G. Kendall. "Separate" no. XVIII from *Biometrika* (1953) **40**, 427. London: Biometrika Office. [20 pp.] 10¾″. 4*s.*

Bessel Functions and Formulae. Compiled by W. G. Bickley. Published for the Royal Society. 1953. Cambridge University Press. [11 pp.] 11″. 3*s.* 6*d.*

Finney's Table, useful for giving at sight critical probabilities in the Four-Fold Table problem, appears in the newly-published *Biometrika Tables for Statisticians*, Table 38, and a full description is provided in the Introduction, p. 65. The table is limited to 15 or less for the two frequencies in one of the margins. The new Table, available as a "separate" from Biometrika, extends the Table, on the same plan, to frequencies of 20, and so enables a wider class of data to be tested by the exact method.

A further instalment of Tables of Symmetric Functions, up to and including weight 12, gives the monomial symmetric functions (M) in terms of the homogeneous product sums (H) and vice-versa. The method of tabulation is as previously, writing the table for each weight as a triangle, associated with a corresponding triangle for the reverse relationship. In this case, however, the diagonal terms are not the same for both, but this has been made clear by using clarendon type for both, with a heavy horizontal line separating them. Brief mention is made in the introduction of the possible uses of the tables in problems of distribution.

The last volume of the Series of British Association Mathematical Tables was Vol. X, being Part II of the Bessel Function series (Functions of positive integer order). This volume was completed by the Royal Society Mathematical Tables Committee, and published in 1952. The introduction incorporated a useful section on Bessel Function Tables. The present separate short publication reprints these ten pages from the larger volume, and also a single page "Summary of Notations," by Dr. J. C. P. Miller, in the belief that the material will be a convenience to all users of Bessel Functions. It is indeed a very useful compendium of known formulae for the various functions, including recurrence formulae and asymptotic expansions, and is available at a modest price.

J. Wishart.

3.—*Statistical Methods in Electrical Engineering.* By D. A. Bell. London: Chapman and Hall, 1953. 175 pp. 9″. 25*s.*

In assessing the merit of any book it is important to know for whom it has been written. From the preface to the present book we learn that it is for the electrical engineer who is a beginner in statistics, and further that "the engineer would need to read more than one of the classic volumes by statisticians and some detailed texts . . . in order to cover his problems of applied statistics". Surely "a concise book on the theory and applications of statistics to electrical engineering" should do two things—first give an outline of methods of statistical reasoning and an indication of which of the engineer's problems may be tackled with its aid and second give the details of sufficient techniques to help the engineer towards the appropriate solutions. But, unfortunately, this volume fails to achieve either of these objects.

To start with, the engineer is bound to be discouraged by chapter titles which appear to him to have very little to do with his own problems. Then the first section, which is made unnecessarily difficult by unfortunate examples, deals with probability theory and appears irrelevant when the complexities are finally dismissed because "for engineering applications the practical position is simple". And, in general, there is a lack of balance, exemplified by a page devoted to the determination of the constant of integration of a Normal distribution curve whereas many more difficult results are quoted not only without proof but with little indication of plausibility. Further, some statements in the book are inaccurate and many others are misleading. Although the expert may be able to understand what is intended, the tyro must inevitably get lost; and practical considerations are hardly mentioned. For example, in dealing with a 2 × 2 contingency table, there is no

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

mention of a continuity correction to χ^2 and the method of calculation given is long-winded. In similar fashion, when dealing with calculations of sums of squares and of cross products for the determination of variances and covariances, the method offered involves the separate calculation of each individual deviation from the mean. Then nowhere in the chapter on the Periodogram and the Autocorrelation function is there mention of any random variation superimposed on the purely periodic. Again, one of the fundamental reasons given for regression analysis is to allow extrapolation; and, as a final example, it is distressing to read that "the statistician's approach is that he knows nothing beyond the given numerical data".

There is an appendix giving notes on tables of statistical functions, which is useful in making some comparisons between the various tables discussed, but is not beyond criticism. For example, areas under the Normal curve are dealt with in three separate sections which could have been brought together.

F. D. K. LIDDELL.

4.—*Population Statistics and their Compilation.* By Hugh H. Wolfenden. The University of Chicago Press, 1954. xxiii + 258 pp. 9″. $7.50.

It is twenty-nine years since the first edition of this well-known book was published, and in preparing the revised edition the author has taken the opportunity of enlarging the original text materially to include references to recent research and developments. Sections have been added on the forecasting of mortality rates and on the theory of reproductivity, and there is an Appendix by W. Edwards Deming on sampling as applied to human populations. There are new paragraphs on population projection and on a number of other subjects, such as the assessment of the importance of different causes of death by means of the measurement of potential years of life lost. The principal extension has, however, been made in the chapter on the construction of mortality tables from population statistics. Mortality, in fact, still accounts for about half of the total contents, and the book thus retains the original characteristic of being more concerned with deaths than with births or marriages, sickness or unemployment.

"Statistics", in the title, implies indexes and standard tables. This is not primarily a manual for registrars and others whose main concern is the collection of population data, although a good introduction to census and registration methods is given. It deals only incidentally with the interpretation of assembled statistics. Its purpose is to guide students and others to the great storehouse of mathematical and statistical techniques available for the convenient summarization and standardization of the new demographic material. Within this field it is very comprehensive, embracing many important studies made not only in the United States but also in Great Britain, Canada and elsewhere. It is well written and effectively presented and contains an extensive bibliography.

Although this work has been and will be of great benefit to students it is still true, as was pointed out in a review of the original version, that it will be of even greater benefit to qualified actuaries and experienced demographers. Students could hardly be expected to have the time to consult all the original papers cited and they are not given a shorter selective list of the more important sources which they might reasonably attempt to trace. Indeed, there is no index of references, although it would have been helpful if one had been made available. Illustrations and practical examples are another aid for which students will have to look elsewhere, for few are provided in the text.

To refer in rather more detail to the contents of the book: the first four sections lead the reader through the fundamentals of demography—the census, the registration of vital events, and the general trustworthiness and characteristic errors of these institutions. With their international approach these preparatory chapters give a very clear idea of the nature of population statistics in the more developed countries. More could, perhaps, have been said about continuous registration systems and about the kinds of error likely to be encountered in fertility censuses and in the collection of dependency statistics. Something might usefully have been added about the difficulties in underdeveloped lands and the efforts of the United Nations Organization to help to overcome them. Again, now that the importance of sampling has been recognized to the extent of adding a special theoretical appendix, it would have been of value to have some account of the practical difficulties normally experienced in this field of activity and the errors likely to be encountered in the collected results of population samples. Apart from these subjects, the presentation of the essential merits and defects of population statistics is complete.

Section V relates to adjustments for errors of age in census and registration statistics and estimates of populations. The author discusses the use of curves in population forecasting, remarking that their use in long-range predictions "is surrounded inevitably by all the uncertainties and dangers of extrapolation", and then refers briefly to projection in age-groups by means of survival ratios. He mentions the three population projections given in the Report of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the Royal Commission but not the wider range offered in the related Statistics Committee Papers, and it is, indeed, curious that none of these interesting, varied and relevant papers receives much attention in the book.

Section VI, which is concerned with the calculation of infantile and other mortality rates, has for the first part of its title "The mathematical relationships between births, deaths and populations . . . ", which might have seemed more appropriate to the later paragraphs on the "theory of reproductivity". This and the next two sections are devoted to the compilation of mortality tables from population statistics by the use of formulae; they are admirably clear and effective and should be of great benefit to all readers. The shorter chapters on other aspects of mortality—methods of comparison, forecasting, cause of death analysis and occupational effects—give a good introduction to the topics in question.

In Section XIII the author turns to the use of census and registration data in the compilation of statistics relating to marriages, births, orphanhood and unemployment. In view of the recent considerable advances in knowledge of the first two of these subjects and the wide interest taken in them today by actuaries and demographers, the brief space allotted to this section is something of a disappointment. The fuller treatment of the theory of reproductivity in later pages suggests a preference for the discussion of mathematical models, in spite of the author's warnings about their limitations. As most studies of fertility and marriage are amenable only to non-mathematical methods, the characteristics of the available data are hardly brought out clearly enough, and some of the definitions given in the section could have been more complete.

The main text concludes with a short chapter on sickness data. In saying that "the possibility of statistical analysis of the various types of sickness . . . is limited to those ailments which are sufficiently serious to require the attention of a doctor" the author omits to mention the recent work done in this country by the Social Survey at the doors of private houses, and some reference to the limitations of this work may be thought desirable in the future. Further editions of "Population Statistics and their Compilation" will surely be called for as the result of increased public demand long before the lapse of another twenty-nine years.

P. R. Cox.

5.—*A Study of Aggregate Consumption Functions.* By R. Ferber. New York: National Bureau of Economic Research, 1953. Tech. Paper 8. 3 p.l., + 72 pp. $11\frac{3}{4}''$. $1.50.

This interesting survey of the problem of describing changes in consumption in terms of some relatively simple empirical function is in two parts. The first and more successful part contains a systematic and critical review of the different functions that have been applied, in all the more important earlier studies, to time series of total consumption. Most of the functions that have been tried are of the simple, linear type. All of them use aggregate current income, and most of them use certain other factors as well—income in the previous year, highest previous income, a time trend, etc.—as independent variables; sometimes the variables are deflated for changes in prices and sometimes, also, for changes in population. Different ways of incorporating all these influences are discussed and the relations between the various functions are clearly and conveniently set out. The author argues that changes in prices, and in population—the latter, in particular, is all too often ignored—should both be taken into account. He is opposed to the use of a time trend, unless an attempt to unravel the causal factors, which would otherwise be caught up in the trend, has previously been made and has proved unsuccessful. He also argues that the consumption function should include some measure, or measures, of the distribution of income. It would indeed be difficult to understand why the distribution of income has so often been neglected, even if its importance had not been demonstrated, empirically, in the few studies where it had been introduced. The author's brief account of the analytical aspects of the problem, although it does not take us very far, is excellent as far as it goes. His arguments throughout this section are clear and cogent. But, having given a critical assessment of the various functions at present in vogue, it is a pity that he did not go on to select those which succeed in passing the theoretical examination, or to introduce the modifications suggested by his own argument, before putting them through the practical tests which are the subject of the second part of the study.

Twenty-two different functions are applied, in the second part, to a single set of data: the revised estimates of consumption in the U.S.A. in 1923–40, made by the Department of Commerce. All the functions are applied to this 18-year period, and most of them are also applied to the same period less the depression years (1931–4), and to the years 1929–40. Altogether, the applications lead to 60 different equations, which are then compared for the accuracy with which they reproduce the estimates on which they are based, i.e., for "goodness of fit". The equations are also used to obtain values for the early post-war years (up to the first half of 1950), and comparison with the corresponding estimates for those years provides a test of what is called "predictive accuracy". The author regards predictive accuracy as much more important than goodness of fit,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This part of the study is carried out in a manner which is workmanlike but rather unimaginative; and the results scarcely justify the promise of the earlier part, or the immense amount of computing work which must have been involved. It is difficult to understand why the author bothers to calculate equations which take no account of changes in prices, or in the total population, after demonstrating that there is really no excuse for omitting either; or why he should completely ignore the effects of changes in the distribution of income, shortly after arguing that even a simple aggregate demand function "must allow for the effects of income distribution not included in the first moment" (p. 18). The first moment being unaffected by the distribution of income, the qualification is superfluous.

It is perhaps less naïf in America than it would be in this country to imagine that pre-war relationships are likely to apply, unaltered, to the post-war world. But it seems unreasonable to assume that the war brought no changes in tastes, or in the distribution of incomes, or in the relative supplies of different commodities, even in the United States. If one considers single commodities, instead of aggregate consumption, this becomes immediately obvious. At all events the application of pre-war relationships to the post-war years hardly constitutes a fair test of predictive accuracy. Such applications would be used, in this country, only to find out whether the demand for particular commodities and the pattern of tastes generally had been altered by the war. The author need not therefore have been troubled or surprised by the absence of any correlation between the goodness of fit of the various equations and their predictive accuracy when applied to the post-war period.

These two aspects of the problem are the only ones that he considers. He appears to have calculated all the regression equations by minimizing the sum of the squares of deviations in the dependent variable. He makes no reference to the possibility of calculating regression equations by minimizing the errors in any of the other variables. He does not make use of double or semi-logarithmic functions. Nor does he consider which of the different variables included in his 60 different equations can be shown, from the results themselves, to have significant effects on consumption. As an alternative method of prediction, he compares the changes from one year to the next, forecast from two of the regression equations, with the actual changes. Such comparisons would, however, have been more to the point if the equations had been fitted to the first differences of the original series. The equations which would then have been obtained would also in some ways probably be more relevant to the problem of prediction.*

The practical examination produces one or two incidental results which are of interest. The depression appears to have brought about a marked change in the relationship between income and consumption. It appears that consumption is influenced by income in the previous year, as well as by income in the current year. The highest previous income also appears to have some effect, though its effect is considered separately from, and not in combination with, that of income in the preceding year. These results cannot, however, be accepted as definite, since no significance tests are applied. In short, the enormous amount of industry which has gone into this work could, one feels, have been directed to rather more useful purpose. J. L. NICHOLSON.

6.—*An International Comparison of National Products and the Purchasing Power of Currencies.* By Milton Gilbert and Irving B. Kravis. Paris : Organisation for European Economic Co-operation, 1954. 203 pp. 9½″.

The dangers of using national income aggregates and constituents in international comparisons have often been listed and discussed—both by those who intend to base their economic analyses on such comparisons and by those who would discourage them. The authors of this report, however, have gone further than any of their predecessors on this theme. Instead of relegating it to a digression on the qualifications of the actual comparisons they have made, they have written a book on the problems of international comparisons in which the quantitative results are merely the end-product of the concepts and technique adopted.

The change of emphasis does not detract from the results. The actual comparisons—both in detail and in the aggregate—gain enormously in interest and conviction from the systematic analysis of their content which this approach involves. The fact that there is no unique solution to each problem in comparison, but at least two different answers dependent on the system of price weights adopted, becomes a source of illumination rather than confusion when the causes and implications of the differences are explained in simple non-technical terms. The inadequacy of international comparisons based on conversion to a common currency by means of exchange rates is effectively illustrated by calculating domestic purchasing power equivalents (i.e., quantity-weighted price indices) analogous to the real national product equivalents (i.e., price-weighted quantity indices).

*Cf. Richard Stone and S. J. Prais, "Forecasting from Econometric Equations: A Further Note on 'Derationing'", *Economic Journal*, March, 1953, p. 189.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The countries which are compared in this study are the United States, the United Kingdom, France, Germany and Italy. The object of the inquiry was "to measure the relative economic ability of the five countries to meet the requirements of present-day existence". This was attempted in terms of a comparison of gross national products analysed into their various expenditure and investment components. The results are given for 1950 (summarily extrapolated to 1952), and for 50 product classes, in the form of binary comparisons between each of the countries concerned and the United States, using United States prices and average European prices respectively as weights. There are detailed descriptions of methods and sources for each country and for the different product groups.

The resources which O.E.E.C. were able to command for this research project were considerable. Acknowledgments are made to five members of O.E.E.C. staff besides the two authors, two special consultants, and to the active participation of the Statistical Offices of the countries concerned, some of which made special collections of data. These contributed to the completion of a highly intensive study in a comparatively short space of time. The results are thus of immediate practical relevance. More important still, however, the methods have been fully considered by an experienced team of investigators. It is in the relatively exhaustive analysis of the conceptual and statistical problems that this study makes its most important contribution to the subject. Its detailed solutions may not always be acceptable: investigators covering different countries and faced with different data limitations would certainly require to find new solutions to many of the specific problems posed. By their unambiguous and consistent statement of the problems involved, however, and by the practical clarity with which they distinguish the problems which they propose to solve from those which they regard as insoluble, the authors succeed in charting an area of study which is relevant to a wider range of issues than those involved in international comparisons. Students of economic growth for a particular country, as well as those interested in international comparisons in these and other groups of countries, will find that a good deal of the tangled undergrowth of muddled thinking about real product comparisons has been cut away by this study.

The main lesson of the experiment seems to be that real product comparisons can be objectively made only within the limits imposed by the character of the economic processes under review. In effect, to measure relative quantities of goods and services produced (or consumed), it is necessary to define them in terms of comparable products; that is, for example, to draw the same line between economic and non-economic activities, or between final and intermediate products, and to ignore quality differences which are not reflected in economic costs. For countries at a broadly similar stage of economic development, or for relatively short periods of time, these adjustments to comparability will be insufficient to affect the validity of the main conclusions. Attempts to compare pre-industrial economies with industrial economies, on the other hand, involve so many adjustments and eliminations that it is only for very limited purposes that the comparable residue can usefully be evaluated. The point is not that no useful purpose can be served by making comparisons of national product over the long period or as between developed and primitive economies, but that the interpretation of the conclusions is a relatively complex business. Such comparisons involve an important element of subjective judgment and even where they are, for convenience, expressed in quantitative terms they are essentially qualitative in character.

P. M. DEANE.

7.—*The Frontiers of Economic Knowledge*. By Arthur F. Burns. Princeton University Press for National Bureau of Economic Research, 1954. xi + 367 pp. 9″. $5.00.

This collection of papers consists in the main of Reports on various aspects of economic growth and fluctuations prepared by Dr. Burns as Director of Research of the National Bureau of Economic Research, but it also includes papers written by him in his private capacity during the past two decades.

The reports recount the most recent chapter of the National Bureau's efforts at impartial and empirical research in economics, a chapter which began when Dr. Burns succeeded Professor Wesley C. Mitchell as Director of Research in 1945, and ended when he was granted leave of absence in 1953 to become Chairman of the President's Council of Economic Advisers.

The problem of economic fluctuations is approached along the lines firmly laid down by his predecessor in his well-known work on Business Cycles. Adding to the work of Mitchell and other colleagues, Burns paints a realistic, yet comprehensive, picture of the round of prosperity and depression. While the central theme of these papers is the type of change called business cycles, this is by no means their only concern. The long cycles that characterize residential construction have also engaged Dr. Burns' attention; indeed the species of change which economists term "secular trends" has been a major subject of investigation by the National Bureau throughout

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

its existence. This book needs to be read in conjunction with Dr. Burns' own analysis of the problem of economic growth published under the title of "*Production Trends in the United States since* 1870".

Dr. Burns emphasizes how little we know about economic behaviour and the need for more systematic scientific work in the cumulation of economic knowledge. Our ignorance is great because "the development of a body of tested knowledge, adequate for coping with Society's ills is bound to be a slow process". Economic research encounters surprises, unpleasant as well as pleasant; but the research for hard factual evidence can be as intellectually rewarding as the exploration of the unscaled peaks of economic theory, a pastime especially popular among British economists in recent years.

Dr. Burns, while stressing some of the repetitive features of the business cycles established by the National Bureau studies, insists: "that it is vital, both theoretically and practically to recognize the changes in economic organization and the episodic and random factors that make each business cycle a unique configuration of events. Subtle understanding of economic change comes from a knowledge of history and large affairs, not from statistics and their processing alone—to which our disturbed age has turned to eagerly in its quest for certainty".

The crucial problem of our times is the prevention of severe depressions, not of business or employment cycles. "It is in this direction that research must move in the future", so that we may determine "why some business contractions are brief and mild while others reach disastrous proportions". Elsewhere he observes "the only things we can be reasonably certain of in the proximate future are, first that our economic system will continue to generate cyclical tendencies, and second that the government will at some stage intervene to check their course". Dr. Burns is rightly critical of the work of recent economic theorists such as Lord Keynes and Professor Hicks, whose writings have fostered the habit of speaking of investment outlets as if they were some objective quantity, independent of the dreams of men, their hopes and fears about government policy, or their expectations about costs, prices and profits. For example, of the latter's recent contribution to the theory of the trade cycle he says: "The sophistication of Hicks' work derives from the pressures of a subtle and enquiring mind, not from a large knowledge of practical affairs or the teachings of history and statistics. The result is a closely reasoned and attractively written essay about a possible cycle, but—as far as I can see—a dubious aid to students seriously concerned with the actual alternations of good and bad trade to which the Western world has been subject in modern times".

It is not possible in a short review to do more than refer briefly to the central theme of these compactly written reports and papers which include not only the work of the Bureau but also introductions to, or reviews of, books dealing with economic growth and its instabilities. Those interested in the subject are strongly advised to read the book itself.

R. GLENDAY.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices published by the Ministry of Labour and National Service rose from 141 (prices at June 17th, 1947 = 100) in March to 142 in April and fell back to 141 in May. The rise in April was due mainly to higher prices for cabbage, tomatoes and fish and to higher local rates in England and Wales. By mid-May the average prices of milk, fish, cheese and coal had fallen, but the effect had been somewhat offset by rises in the price of butter, tea, potatoes and fruit. Separate figures on the same basis (i.e., June, 1947 = 100) are not available for different groups of commodities, but the following are the figures based on January 15th, 1952 = 100.

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*House-hold Durable Goods*	*Miscel-laneous Goods*	*Services*	*Alco-holic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
March 16th, 1954	111·6	110·3	96·3	112·0	95·6	100·0	109·7	101·5	100·3	106·6
April 13th, 1954	112·6	111·6	96·3	112·1	95·2	99·9	109·9	101·4	100·3	107·0
May 18th, 1954	112·1	111·7	96·3	109·6	95·2	100·1	109·9	101·4	100·3	106·7

The Ministry of Labour index of weekly wage rates, which was 139 (June 30th, 1947 = 100) in March rose to 141 in April and 142 in May. The principal classes of workers whose wage rates were increased in the two months included those in the engineering and shipbuilding industries, in iron and steel manufacture, the wool textile industry, building and civil engineering and tailoring. In May the wage rate index exceeded the retail prices index, by one point. In the case of the index of average weekly earnings the excess in October, 1953, the latest date for which the figure is available, was 17 points higher than the wage rate index.

The total working population and the numbers in civil employment in the three months ended April, 1954, were as follows:—

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Feb., 1954	15,931	7,533	23,464	14,879	7,395	22,274
Mar., 1954	15,901	7,531	23,432	14,876	7,398	22,274
April, 1954	15,917	7,556	23,473	14,907	7,430	22,337

The number of persons on the unemployment registers of the Employment Exchanges fell by 26,300 between March and April and by a further 27,200 by May. The total of 289,426 at May, 1954, represented 1·4 per cent. of the estimated total employees in Great Britain. The percentage in the separate Regions ranged from 0·6 in the Midlands and North Midlands to 2·3 in Northern, 2·9 in Scotland and 2·5 in Wales.

The following is a sex analysis of the figures:

Number of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
March 15th, 1954	224,138	118,728	342,866
April 12th, 1954	203,295	113,290	316,585
May 10th, 1954	184,701	104,725	289,426

Of the total of 289,426 at May 10th, 78,522 had been unemployed for not more than two weeks, 63,106 from two to eight weeks, and 134,666 for over eight weeks, while 13,132 were temporarily stopped.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed, were 1,007,000 in March, 901,300 in April and 904,100 in May. The numbers of employed persons absent owing to industrial injuries were 63,300, 58,400 and 59,400.

The *Ministry of Labour Gazette* for June, 1954, contains an age analysis of the employee population of Great Britain in May, 1953. Of the total of 13,720,000 males 190,000 were 70 and over and 537,000 were 65 and over. Amongst 7,160,000 females 43,000 were 70 and over and 124,000 65 and over. Comparisons with previous figures show that of 434,000 men aged 62 to 64 in 1950, 187,000 had left employment by 1953 and of 486,000 aged 65 and over, 193,000 had left. In the case of women on the other hand the number aged 50 to 59 in 1950 was 918,000 and this had risen to 1,051,000 by 1953. The number aged 60 and over rose from 275,000 to 333,000. The analysis contains separate figures for industries and Regions, figures relating to married women and some details of regional migration.

Guides to Official Sources: No. 3, *Local Government Statistics* (H.M.S.O. 1*s.* 6*d.*) continues the useful series of reports issued by the Interdepartmental Committee on Social and Economic Research. This committee, working mainly through *ad hoc* sub-committees surveys the information available in and published by government departments. While the Interdepartmental Committee and its sub-committees have academic as well as departmental members the reports suffer from their official parentage. No word of critical comment either on the statistics themselves or on the organization for their collection, collation, and publication, finds its way into these reports. Guide No. 3 on Local Government Statistics, however, certainly provides a most comprehensive handbook of sources. Certain features strike the reader as particularly helpful for research purposes. In the first place, the survey embraces the statistics relating to local government collected and published not only by the Ministry primarily concerned but also by other Government departments. Secondly, some attention is given to unpublished returns, available within government departments, which can be used by accredited research workers on application. Thirdly, reference is made to non-official sources of information. These last are vital at the present time in the field of local government. The returns published by such bodies as the Institute of Municipal Treasurers and Accountants or the Society of County Treasurers provide a wealth of material relating to individual local authorities not at present collected together in any official publication.

In addition to covering current statistics of local government collected (*a*) by the Ministry of Housing and Local Government, (*b*) by other government departments (*c*) by non-governmental organizations, Guide No. 3. contains a very useful historical survey of statistics relating to local government finance. Another welcome feature is the attention given, with regard both to historical and current material, to Scottish local government.

The Guide will be invaluable to all users of local government statistics, and as a document officially sponsored, could hardly be bettered. It remains, nevertheless, to regret the continued dearth of critical commentaries on descriptive statistics of different kinds covering not only where the figures are to be found but also their interpretation, shortcomings, significance, and relationship to other material.

---

(2) Other Statistics

The Economic Commission for Europe has recently published two reports on the Steel industry. The first (*The European Steel Market in* 1953 (100 pp.), 5*s.*, 1954) discusses with a wealth of statistical material the trends in steel production and in the supply and demand for steel-making raw materials in West Europe, the pattern of trade, consumption and an analysis of steel demand. In 1953 the supply of steel in Europe exceeded demand (except in the United Kingdom). The report discusses how the decrease in demand might be overcome. Production should not, it is held, be adjusted to meet a permanently lower level of demand but the latter should be stimulated by closer association, both technically and commercially, between the industry and its chief consumers. That production should be adjusted to meet a lower level of demand could only retard efficiency, raise prices and reduce demand.

The second report (*Competition between Aluminium and Steel* (31 pp.), 9*s.*, 1954) describes first in detail the growth of the aluminium industry on a world-scale, and attempts to define the area of competition in Europe. Aluminium output is at present increasing by about 10 per cent. per annum. Competition between the two metals is small but slowly increasing especially in thin

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

sheets, and to a smaller extent in tubes and light castings and forgings. About half the aluminium consumed is, it is estimated, in direct competition with iron and steel. The report concludes that inroads into the steel industry can only be small for many years to come and that the cumulative effects of growing competition between the two industries should not only be mutually beneficial but should stimulate research for lower cost of production.

The attention of Fellows is drawn to a recent UNESCO publication entitled *World List of Social Science Periodicals* (UNESCO Publication 189 : 1954—H.M.S.O. price 9*s.* 6*d.*). It provides the social sciences with a bibliographical service similar to the World List of Scientific Periodicals which is both well-known and well-established in the field of the natural sciences. In this new World List are mentioned some 700 publications appearing in 51 countries. They are specialized either in the general field of the social sciences or in one of those sciences: periodicals containing studies on statistical problems have also been included. The periodicals are listed in alphabetical order within countries, which are themselves shown in alphabetical order of their names in the French language. Four indexes, i.e., straight alphabetical, publishing institution, subject and specialized subject, facilitate the use of this valuable new source of reference.

Newspaper Reading by University Students. In a Survey carried out by S. Moos, A. Laing, A. J. Odber (Lecturers in Economics), and Dr. P. A. Bromhead (Lecturer in Politics), of the Department of Social Studies, Durham Colleges (February, 1954: 55 pp., price 2*s.* 6*d.*) it appears that university students in the north of England read newspapers for the main purpose of keeping abreast of the more important news items. In this they do not differ from the rest of us. But, although sweeping generalizations are dangerous, we now know that at Durham Colleges in 1953, sporting news made a stronger appeal to science than to art students, and was more popular with both than editorials. About a quarter of the students show an interest in crosswords, and approximately the same proportion, more especially the art students, read the reviews of books and plays. Half as many women as men are interested in sports news, but twice as many women as men read reviews of books and the theatre and art. The report recently published by the Durham Colleges gives the results of a five-point questionnaire the answers to which were filled in anonymously by some 200 men and women selected as a cross section of 1121 students. A method of stratified random sampling was preferred to a full scale enquiry as likely to result in a more serious and responsible result. The Durham Colleges have shown initiative in making a survey of newspaper reading by their students and the information gleaned will be of interest to the Common Rooms and Students Unions of other Universities. It is probably the first attempt to examine closely the reading habits of a relatively homogeneous group. There have, however, been national reading surveys to ascertain why people in various income groups prefer one newspaper to another, (e.g. The Hulton Readership Survey of 1953).

The Durham survey tells us that between them the 226 students read 470 daily newspapers and 419 Sunday papers. The provision of newspapers in the common rooms probably explains why more papers are read in term time than during vacations. The men prefer dailies to weeklies, the women prefer weekly to daily reading. Over 40 per cent. of all the reading of daily newspapers by Durham men and women students in term time seems, from the evidence, to be concentrated on the *Manchester Guardian*, *The Daily Telegraph* and *The Times*. In vacations the three halfpenny papers found in the homes become more prominent, but in many cases the term time habits stick. On Sundays *The Observer* had a strong following. One half of the leisure reading of weeklies in term time is directed to *Punch*, *Picture Post*, *Illustrated* and *The Listener*. It is more difficult to introduce students to economic and technical journals and these, even when made available by the self governing organizations of students, have a small following. The Lecturers who organized the sample enquiry have thrown light on the attitude of science and art students to newspapers and periodicals. They claim that the evidence on vacation reading shews that the University, through the provision of good current reading matter in its common rooms, can play an important role in shaping and widening the field of vision of the students.

CURRENT NOTE

Fellows will be interested to hear of the appointment of Mr. E. Grebenik, Reader in Demography at the London School of Economics, to the Chair of Social Studies in the University of Leeds. Mr. N. H. Carrier succeeds Mr. Grebenik at the London School of Economics.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

April 1954—Some problems of inter-plant cost comparisons: *W. F. Luttrell.* Contemporary concepts of business net income—the shares of capital and labour, and the influence of public opinion: *J. D. Edwards.* Accounting dynamics: *F. Sewell Bray.*

Agricultural Economics Society, Journal of Proceedings—

March 1954—Changes in the productivity of labour in British agriculture: *H. T. Williams.* Gross and net farm rent in the United Kingdom, 1867–1938: *J. R. Bellerby.* A note on the representative farm: *A. H. Maunder.*

Biometrika—

June 1954—Distribution theory of two estimates for standard deviation based on second variant differences: *A. R. Kamat.* The statistical treatment of mean deviation: *J. H. Caldwell.* Tests of linear hypotheses in univariate and multivariate analysis when the ratios of the population variances are unknown: *G. S. James.* The use of the Hankel transform in statistics: *R. D. Lord.* A note on the consistency and maxima of the roots of likelihood equations: *K. C. Chanda.* Grouping methods in the fitting of polynomials to equally spaced observations: *P. G. Guest.* New techniques for the analysis of absenteeism data: *A. G. Arbous* and *H. S. Sichel.* On the superposition of renewal processes: *D. R. Cox* and *W. L. Smith.* Continuous inspection schemes: *E. S. Page.* On Nahordnung and Fernordnung in samples of literary texts: *W. Fucks.* A distribution-free k-sample test against ordered alternatives: *A. R. Jonckheere.* Two-stage procedures for estimating the difference between means: *S. G. Ghurye* and *H. Robbins.* A bivariate generalization of Student's t-distribution, with tables for certain special cases: *C. W. Dunnett* and *M. Sobel.* A two-sample multiple decision procedure for ranking means of normal populations with a common unknown variance: *R. E. Bechhofer, C. W. Dunnett* and *M. Sobel.* Inequalities for the normal integral including a new continued fraction: *L. R. Shenton.* A confidence region for the solution of a set of simultaneous equations with an application to experimental design: *G. E. P. Box* and *J. S. Hunter.* On the moments of order statistics in samples from normal populations: *H. Ruben.* Statistical treatment of censored data Part I, Fundamental formulae: *F. N. David* and *N. L. Johnson.* Simplified decision functions: *G. A. Barnard.* Sequential tests for binomial and exponential populations: *F. J. Anscombe* and *E. S. Page.* Tables of generalized k-statistics: *S. H. Abdel-Aty.* An angular transformation for the serial correlation coefficient: *G. M. Jenkins.* A distribution arising in the study of infectious diseases: *J. O. Irwin.* A note on contagious distributions: *H. R. Thompson.* A general expression for the mean in a simple stochastic epidemic: *H. W. Haskey.* Some remarks on confidence or fiducial limits: *T. E. Sterne.* A note on the probability integral of the correlation coefficient: *B. I. Harley.* A simplified expression for the variance of the χ^2-function on a contingency table: *R. B. Dawson. Jr.*

Economica—

February 1954—Seasonal variation in retail prices: *R. G. D. Allen.*

Economic Journal—

June 1954—Imperial preference: a quantitative analysis: *Sir D. Macdougall* and *R. Hutt.*

Faculty of Actuaries, Transactions—

Vol. 22, Part 2, No. 182—British Government securities: *J. B. Marshall.* Active investment policy related to the holding of matched assets: *D. J. Robertson.*

Incorporated Statistician—

March 1954—National income statistics: are they useful?: *C. T. Saunders.* Social class in sample surveys: *J. S. Downham.* Difficulties and dangers in statistics in industry: *C. Davenport Hughes.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Institute of Actuaries, Journal—

Vol. 80, Part I, No. 354—The concept of probability: *R. D. Clarke.* New formula for the number of minimal lattice paths: *M. T. L. Bizley.* Symmetry in central polynomial interpolation: *H. Vaughan.* Some statistical aspects of mortality from degenerative heart disease: *R. H. Daw.*

Journal of Documentation—

March 1954—The preparation of subject-heading lists by automatic punched-card techniques: *E. Garfield.*

Oxford Economic Papers (New Series)—

June 1954—Variations in the rate of economic growth in the U.S.A., 1869–1939: *B. Weber* and *S. J. Handfield-Jones.*

Oxford University Institute of Statistics, Bulletin—

February and March 1954—Earnings in the boot and shoe industry: *K. G. J. C. Knowles* and *M. Verry.* The reform of E.P.U.: *J. R. Sargent.* East-West trade: *A. Maddison.*

April 1954—Household income, rent and rates: *H. F. Lydall* and *R. F. F. Dawson.* A "human needs" diet, spring 1954: *T. Schultz.*

INDIA—

Calcutta Statistical Association Bulletin—

March 1954—Critique of National Sample reports: *H. K. Nandi.* A method of discrimination in time series analysis: *A. Rudra.* A variance in a real sampling: *B. Ghosh.* A method of selection for improvement: *J. Roy* and *S. Mitra.* Rectangular lattices and OGD designs: *P. M. Roy.*

Sankhyā—

March 1954—On strongly continuous stochastic processes: *E. Lukacs.* Analysis of the 1939 model sample survey results from the view-point of integral geometry: *M. Masuyama.* Some experiments with different types of area sampling for winter paddy, in Giridih, Bihar, 1954: *J. M. Sengupta.* Mathematical note on area sampling: *M. Masuyama.* On selecting random numbers for large-scale sampling: *A. Matthai.* On the punched card method in smoothing for age bias in census returns: *K. C. Podder.* National Sample Survey Number 2: Tables with notes on the second round.

UNION OF SOUTH AFRICA—

South African Journal of Economics—

March 1954—21 years in retrospect. (Special coming of age issue.)

UNITED STATES—

American Economic Review—

June 1954—Recent changes in income inequality: *R. J. Lampman.* The price level in macroeconomic models: *L. Hough.* The growth of American unions: *I. Bernstein.* Manpower allocation under British planning: *S. E. Rolfe.* Economic effects of French minimum wage law: *H. C. Eastman.*

American Statistical Association, Journal—

March 1954—The present structure of the Association: *W. G. Cochran.* Principles of sampling: *W. G. Cochran, F. Mosteller* and *J. W. Tukey.* Do persons lost to long term observation have the same experience as persons observed? *T. J. Bauer, J. F. Donohue, V. Larsen, A. P. Iskrant* and *Q. R. Remein.* Applications of statistical methods of sedimentary rocks: *W. C. Krumbein.* Relationship between an index of house prices and building costs: *D. M. Blank.* Cycles in the balance of payments: *S. Fabricant.* Demand analysis: *H. S. Houthakker.* Some practical techniques in serial number analysis: *L. A. Goodman.* The problem of autocorrelation in regression analysis: *R. L. Anderson.* Joint confidence regions for multiple regression coefficients: *D. Durand.* Asymptotic relative efficiencies of distri-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

bution-free tests of randomness against normal alternatives: *A. Stuart.* Estimation of the Poisson parameter from truncated samples and from censored samples: *A. C. Cohen, Jr.* Tables of the expected value of 1/X for positive Bernoulli and Poisson variables: *E. L. Grab* and *I. R. Savage.*

American Statistician—

February 1954—Limits of mathematics in statistics: *W. S. Woytinsky.* One consumer's view of the current population survey: *A. J. Jaffe.* Estimating daily order receipts from weight of mail: *C. W. Smalley.*

April-May 1954—The design of experiments in naval engineering: *B. B. Day.* Analysing business cycles: *G. H. Moore.*

Annals of Mathematical Statistics—

March 1954—The estimation of biological populations: *D. G. Chapman.* A single-sample multiple decision procedure for ranking means of normal populations with known variances: *R. E. Bechhofer.* Normal multivariate analysis and the orthogonal group: *A. T. James.* The maxima of the mean largest value and of the range: *E. J. Gumbel.* Universal bounds for mean range and extreme observation: *H. O. Harley* and *H. A. David.* Some theorems for partially balanced designs: *H. O. Hartley.* On the reduced moment problem: *S. H. Khamis.* Spacing of information in polynomial regression: *A. de la Garza.* Generalization of the theorem of Glivenko-Cantelli: *J. Wolfowitz.* On Lehman's two-sample test: *R. M. Sundrum.* Tables for a nonparametric test of location: *S. Rosenbaum.* On the problem of construction of orthogonal arrays: *E. Seiden.* Admissible tests for the mean of a rectangular distribution: *A. Birnbaum.* The monotonicity of the ratio of two noncentral *t* density functions: *W. Kruskal.* An extension of the Borel-Cantelli lemma: *S. W. Nash.* The distribution of radial error: *H. Weil.*

June 1954—Estimation by the minimum distance method in nonparametric stochastic difference equations: *J. Wolfowitz.* Asymptotic distribution of serial statistics and applications to problems of nonparametric tests of hypotheses: *M. N. Ghosh.* On the estimation of regression coefficients in the case of an autocorrelated disturbance: *U. Grenander.* A single-sample multiple decision procedure for ranking variances of normal populations: *R. E. Bechhofer* and *M. Sobel.* Some theorems on quadratic forms applied in the study of analysis of variance problems, I. Effect of inequality of variance in the one-way classification: *G. E. P. Box.* Least-squares estimates using ordered observations: *F. Downton.* Estimation of the mean and standard deviation by order statistics: *A. E. Sarhan.* On multivariate distribution theory: *I. Olkin* and *S. N. Roy.* On the computation of the sampling characteristic of a general class of sequential decision problems: *G. E. Albert.* Sequential procedures in certain components of variance problems: *N. L. Johnson.* On quadratic estimates of variance components: *F. A. Graybill.* Some theorems relevant to life testing from an exponential distribution: *B. Epstein* and *M. Sobel.* Approximation of methods which converge with probability one: *J. R. Blum.* A note on the Robbins-Monro stochastic approximation method: *G. Kallianpur.* A property of the normal distribution: *E. Lukacs* and *E. P. King.* On optimal systems: *D. Blackwell.* Density unbiased point estimates: *R. P. Peterson.* Some properties of beta and gamma distributions: *M. V. Jambunathan.* On some functions involving Mill's ratio: *D. F. Barrow* and *A. C. Cohen, Jr.*

Biometrics—

March 1954—The design of chemical experiments: *D. R. Read.* The exploration and exploitation of response surfaces: some general considerations and examples: *G. E. P. Box.* Doubly balanced incomplete block designs for experiments in which the treatment effects are correlated : *L. D. Calvin.* Fixed-sample-size analysis of sequential observations: *F. J. Anscombe.* The combination of estimates from different experiments: *W. G. Cochran.* The analysis of variance with various binomial transformations: *R. A. Fisher.* Suggested desk calculator operations for computing moments by the row: *F. M. Hemphill.*

Econometrica—

January 1954—Transivity, utility, and aggregation in preference patterns: *K. O. May.* Some problems in the theory of dynamic programming: *R. Bellman.* On the programming of nonlinear production functions: *H. Nikaido.* Note on the economic equilibrium for non-linear models: *N. Georgescu-Roegen.* L'utilisation de l'outil mathématique en économique:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

M. Allais. Edgeworth's Taxation Paradox, and the nature of demand functions: *M. J. Bailey.* The teaching of econometrics: *G. Tintner.*

April 1954—On equilibrium in Graham's model of world trade and other competitive systems: *L. Mackenzie.* Causality and econometrics: *H. O. A. Wold.* Standard error of forecast of a complete econometric model: *T. M. Brown.* A model for programming and sensitivity analysis in an integrated oil company: *A. Charnes, W. W. Cooper* and *B. Mellon.* An example of autocorrelated disturbances in linear regression: *J. Gurland.* Autoregression in the United States economy: *A. J. Gartaganis.* An inventory problem: *M. Rosenblatt.*

Harvard Business Review—

January-February 1954—The learning curve as a production tool: *F. J. Andress.*

May-June 1954—Mathematical programming: better information for better decision making: *A. Henderson* and *R. Schlaifer.* How much should a company spend on research?: *H. S. Turner.*

Mathematical Tables and Other Aids to Computation—

January 1954—On modified divided differences I: *G. Blanch.* A minimum problem solved by mesh methods: *G. C. Best.* A modification of the Aitken-Neville linear iterative procedures for polynomial interpolation: *M. C. K. Tweedie.*

April 1954—An analysis of a logical machine using parenthesis-free notation: *A. W. Burke, D. W. Warren* and *J. B. Wright.* Polynomial-like approximation: *O. Gross.* A loragithm-algorithm: *D. Shanks.* The product form for the inverse in the simplex method: *G. B. Dantzig* and *W. Orchard-Hays.* On modified divided differences II: *G. Blanch.*

Psychometrika—

March 1954—On estimation of parameters in latent structure analysis: *T. W. Anderson.* Solution of the personnel classification problem with the method of optimal regions: *P. S. Dwyer.* The mathematical theory of factorial invariance under selection: *Y. Ahmavaara.* The square root method and multiple group methods of factor analysis: *H. H. Harman.* A second-order factor analysis of reasoning abilities: *L. Matin* and *D. C. Adkins.* Note on the selection of a panel of judges so as to maximise panel efficiency: *S. Harrison, N. H. Ishler* and *E. M. Laue.*

Review of Economics and Statistics—

February 1954—Size distribution of income since the mid-thirties: *S. Goldsmith, G. Jaszi, H. Kaitz* and *M. Liebenberg.* Statistical studies of unincorporated business: *L. R. Klein* and *J. Margolis.* A note on depreciation, replacement and growth: *E. Schiff.* A note on the volume of Soviet investment: *A. Nove.* Some comments on the "simultaneous equations approach": *J. R. Meyer* and *H. L. Miller, Jr.* The usefulness of the factor cost concept in national income accounting: *J. W. Kuhn.*

May 1954—The nature and significance of input-output: *R. Dorfman.* Real wages in the Soviet Union, 1928–1952: *J. G. Chapman.* German terms of trade by commodity classes and areas: *C. P. Kindleberger.* The functional distribution of income in the United States, 1850–1952: *D. Gale Johnson.* Proposals for improving income and product concepts: *J. Mayer.*

BELGIUM—

Bulletin de l'Institut de Recherches Économiques et Sociales—

May 1954—La Belgique en 1953. (Whole number.)

FRANCE—

Journal de la Société Statistique de Paris—

October-December 1953—Remarques sur la notion de productivité: *R. Roy.* Le contrôle statistique des parités monétaires: *P. Gorra.* Chronique des statistiques bancaires et des questions monétaires: *P. Cauboue.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

GERMANY—

Allgemeines Statistisches Archiv—

Vol. 38, Part I—Stichprobenpläne für Konsumerhebungen: *L. Bosse.* Über einige Stichprobenprobleme bei der Vorbereitung des deutschen Mikro-zensus: *S. Koller.* Stichprobenverfahren in der amtlichen westdeutschen Agrarstatistik: *H. Strecker.* Studie zur Frage des Familieneinkommens: *H. Schmucker.* Eine Abschätzung der Nährstoffpreise in den Nahrungsmitteln: *H. Kraut.*

Mitteilungsblatt für Mathematische Statistik—

Vol. 6, Part 4—Das Mutungsproblem der Besetzungs-Verteilung: *W. Schäfer.* Spieltheoretische Behandlung eines Reklameproblems: *E. Burger.* Einige Bemerkungen zu Burgers Variante eines Spielmodells von Gillman: *E. Fels.* Über Stellenumfang und Rundungsregeln von Uraufschreibungen: *U. Graf* and *R. Wartmann.* Die Grundlagen für die Anwendung der Entscheidungsanalysen im erbbiologischen Vaterschaftschweis: *R. K. Bauer* and *H. Baitsch.* χ^2-Test zur Prüfung der Symmetrie bezüglich Null: *E. Walter.*

Weltwirtschaftliches Archiv—

Vol. 72, Part I—Econometrie models and welfare maximisation: *H. Theil.* The concept of energy in economics: *S. D. Zagoroff.*

HOLLAND—

Statistica—

Vol 7, No. 3—Richtlijnen voor de berekening van productie-indices: *J. W. E. Vos.* Methoden voor het vergelijken, toetsen en schatten van onbekende kansen: *C. van Eeden.* Het uitzen van waarnemingen op waarschijnlijkheidspapier: *A. Benard* and *E. C. Bos-Lenevbach.*

ITALY—

Statistica—

January-March 1954—Ancora sulle misure statistiche della variabilitá con particolare riferimento all'indice di oscillazione: *P. Fortunati.* Un criterio per la determinazione di indici di cograduazione tra serie statistiche con ripetizioni: *V. Amato.* Sulla natimortalità: *R. Lenzi.*

JAPAN—

Annals of the Hitotsubashi Academy—

April 1954—The income growth and the rate of saving in Japan: *Y. Yamada.* Business income during the inflation in Japan: *I. Katano.* Mathematical analysis of the metabolism and analogy of economics: *M. Sugita.*

NORWAY—

Statistiske Meldinger—

No. 5, 1954—Prognose for befolkningsutviklingen fram til utgangen av 1970: *J. E. Backer.*

SWEDEN—

Statistisk Tidskrift—

April 1954—Utredningsinstitutet. 2: Fältorganisationen: *V. T. Dalenius.*

YUGOSLAVIA—

Statstiĉka Revija—

April 1954—Povodom osnivanja Jugoslovenskog statističkog društva: *D. Vogelnik.* Kvantitativna ekonomska analiza i drustveno računovodstvo: *A. Orthaber.* Diskusija o standardnoj griješki dvoetaphnih uzoraka: *J. Ećimović.* Efikasnost pojedinih tipova stratificiranog uzorka kod fiksnih troškova: *M. Blejec.*

INTERNATIONAL

F.A.O. Monthly Bulletin of Agricultural Economics and Statistics—

April 1954—Notes on statistical methods for African agriculture.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part II, 1954, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Air Ministry.* Averages of bright sunshine for Great Britain and Northern Ireland, 1921–50. London, H.M.S.O., 1953. [ii], 32p. 9½″. 2*s.* (M.O.572.)

Averages of temperature for Great Britain and Northern Ireland, 1921–50. London, H.M.S.O. 1953. [ii], 36p. 9½″. 2*s.* (M.O.571.)

Board of Trade. Report on the census of production for 1951: introductory notes ... London, H.M.S.O., 1954. xiip. 11¼″. 1*s.* 6*d.*

Colonial Office. Report of the second conference of colonial government statisticians, 1953. London, H.M.S.O., 1954. 52, [1]p. 9½″. 2*s.*

General Register Office. Census 1951 England and Wales: County report ... Cheshire. xlviii, 99p. 25*s.* Hertfordshire. xlv, 74p. 21*s.* Kent. xlix, 110p. 25*s.* Yorkshire West Riding. l, 177p. map. 37*s.* 6*d.* London, H.M.S.O. 1954. 13″.

The Registrar-General's decennial supplement England and Wales 1951: Occupational mortality Part I ... London, H.M.S.O., 1954. iv, 75 p. 13″. 7*s.* 6*d.*

The Registrar General's statistical review of England and Wales for the year 1949: supplement on hospital in-patient statistics. London, H.M.S.O., 1954. xii, 485p. 9½″. 15*s.*

Ministry of Housing and Local Government. Houses: the next step. London, H.M.S.O., 1953. 20p. 9½″. 9*d.* Cmd. 8996.

Monopolies and Restrictive Practices Commission. Report on the process of calico printing ... London, H.M.S.O., 1954. iv, 128p. 9½″. 4*s.* 6*d.*

Scotland. Department of Agriculture. Hill farm research: second report of the Scottish Hill Farm Research Committee. Edinburgh, H.M.S.O., 1953. 108p. 9½″. 3*s.* 6*d.*

Scotland. General Registry Office. Census 1951: report on the fifteenth census of Scotland ... Vol. I.—Part 19. County of Kincardine. 34p. 7*s.* 6*d.* Part 20. County of Kirkcudbright. 38p. 8*s.* 6*d.* Edinburgh, H.M.S.O., 1954. 13″.

Scotland. Home Department. Industry and employment in Scotland 1953 ... Edinburgh, H.M.S.O., 1954. 71p. 9½″. 2*s.* 6*d.* Cmd. 9102.

Scotland. Secretary of State. Housing policy: Scotland ... London, H.M.S.O., 1953. 10p. 9½″. 6*d.* Cmd. 8997.

Australia. *Bureau of Census and Statistics.* Census of the Commonwealth of Australia, 30th June, 1947. Vol. III: comprising parts XX to XXVIII of the detailed tables, Statistician's report and Australian life tables. Canberra, 1954. various paging. maps. tabs. 12¾″.

Canada. *Dominion Bureau of Statistics.* Ninth census of Canada 1951; Vol. III: Housing and families. Ottawa, 1953. various paging. 11″. $3.

Denmark. *Arbejds- og Socialministeriets.* Aftrapning efter lokalitet af ydelser og indtaegtsgraenser inden for sociallovgivningen; en redegørelse af arbejds- og socialministeriets statsvidenskabelige konsulent. *Socialt Tidsskrift* (1954), 327–354. 9″. 2 *Dan.kr.* (Økonomoisk-Statistiske Undersøgelser 17.)

Socialpolitikken i Danemark siden socialreformen belyst ved udviklingen i de sociale udgifter; en undersøgelse ved arbejds og socialministeriets statsvidenskabelige konsulent. København, 1954. 181, [2]. p. 9″. 7 *Dan.kr* 50*øve.* (Økonomisk-Statistiske Undersøgelser 18.)

Food and Agriculture Organization. European agriculture: a statement of problems. (prov. ed.) prepared jointly by the Secretaries of the United Nations Economic Commission for Europe and the Food and Agriculture Organization of the United Nations. Geneva, 1954. vii, 83p. 11″.

France. *Institut National de la Statistique et des Études Économiques.* Annuaire de la Guyane, 1947–1952. Paris, Imprimerie Nationale, 1953. 87p. 10½″.

Note sur les statistiques démographiques des territoires d'outre-mer. (Population autoshtone des territoires Africains et États Associés d'Indochine.) Paris, Imprimerie Nationale, 1953. 78p. 10½″.

Germany. *Statistische Bundesamt.* Die Bevölkerung der Bundesrepublik Deutschland nach der Zählung vom 13.9.1950. Heft 4. Die Haushaltungen. Heft. 6. Die Körperbehinderten. 2 vols. (Statistik der Bundesrepublik Deutschland 35). Die gewerblichen Strassenverkehrsbetriebe in der Bundesrepublik Deutschland am 15.5.1951 und die Verkehrsleistungen im gewerblichen Güterkraftverkehr im Mai 1951. (Zusatzerhebung zur Volkszählung vom 13.9.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

1950.) xiii, 97p. (S.B.D.48.) Die Verwendung von Schleppern, Bodenfräsen und Mähdreschern in der Land- und Forstwirtschaft: Ergebnisse der Schleppererhebung vom Mai, 1953. 53p. (S.B.D. 94.) Die Schulden von Bund, Ländern und Gemeinden am 31. Marz, 1953. 51p. (S.B.D. 98.) Stuttgart-Köln, W. Kohlhammer, 1954. 11¾″.

India. *Ministry of Home Affairs. Office of the Registrar General.* Census of India; 1951: Life tables. [Compiled by Shri Jain from the census of India.] New Delhi, 1954. [iv], 60p. 10¾″. 1*s.* 6*d.* (Census Paper 2.)

New Zealand. *Census and Statistics Department*, Census of distribution 1953. Wellington, 1954. 68p. fol. tabs. 12¼″.

Norway. *Statistisk Sentralbyrå.* Folkemengden i herreder og byer 1, Januar, 1952. Population in rural districts and towns, January 1, 1952. Oslo, 1953. 41p. 8½″. *Kr.* 2. (Norges Offisielle Statistikk XI. 134.)

Folketellingen i Norge, 3 Desember, 1946, sjette hefte: Yrksstatistikk. VI. Statistique de professions: recensement de la population le 3 décembre, 1946. Oslo, 1954. 63, 379p. 9½″. (Norges Offisielle Statistikk XI. 155.)

Folketellingen i Desember 1950, sjuende hefte; Trossamfunn. Population census, December 1, 1950, seventh volume: Religious denominations. Oslo, 1954. 42p. 9½″. *Kr.* 2. (Norges Offisielle Statistikk XI. 153.)

Southern Rhodesia. *Central African Statistical Office.* Census of population 1951. Salisbury, 1954. [vi], 122p. fol. tabs. 13″.

Switzerland. *Eidgenössisches Statistisches Amt.* Eidgenössische Volkszählung 1 Dezember, 1950: Band 5. Kanton Bern. Bern, 1954. 354p. 11¾″. (Statistiches Quellenwerke der Schweiz. Hefte 251. Reihe Ae. 5.)

United Nations. Report on international definition and measurement of standards and levels of living; report of a committee of experts convened by the Secretary-General of the United Nations, jointly with the International Labour Office and the United Nations Educational Scientific and Cultural Organization. New York, 1954. xii, 95p. 10¼″.

Department of Economic Affairs. The international flow of private capital, 1946–1952. New York, 1954. v, 61p. 9″. 3*s.*

Department of Social Affairs. Population Division. Future population estimates by sex and age. Report I: the population of Central America (including Mexico), 1950–1980. New York, 1954. [vi], 84p. map. 10¾″. 5*s.* (Pop. Stud. 16.)

The determinants and consquences of population trends: a summary of the findings of studies on the relationships between population changes and economic and social conditions. New York, 1954. xii, 404p. maps. 11″. 30*s.* (Pop. Stud. 17.)

Educational, Scientific & Cultural Organization. International Studies Conference. The university teaching of social sciences international relations; a report prepared by C. A. W. Manning on behalf of the International Studies Conference. Paris, UNESCO, 1954. 100p. 8½″. 4*s.*

United States of America. *National Bureau of Standards.* Tables of Lagrangian coefficients for sexagesimal interpolation. Washington, Supt. of Documents, 1954, ix, 157p. 10¼″. $2. (Appl. Maths. Ser. 35.)

Table of secants and cosecants to nine significant figures at hundredths of a degree. Washington, Supt. of Documents, 1954. vi, 10¼″. 35*c.* (Appl. Maths. Ser. 40.)

World Health Organization. First international conference of national committees on vital and health statistics: report. Geneva, 1954. 28p. 9½″. 1*s.* 9*d.* (Wd. Hlth. Org. Techn. Rep. Ser. 85.)

Yugoslavia. *Federal Statistical Office.* Konačni rezultati popisa stanovnistva od 15 marta 1948 godine: Knjiga VII: Stanovništvo prema bračnom stanju ... Final results of the population census of March 15th, 1948; Volume VII: Population by marital status. Beograd, 1954. lxxii, 475p. 11½″.

II.—AUTHORS AND MISCELLANEOUS

Allais (Maurice). Traité d'économie pure: Tome I. Les données générales de l'économie pure Tome II. La dynamique du déséquilibre. Tome III. La dynamique de l'équilibre. Tome IV. Le salaire et la rente foncière. Annexes. 2nd ed. Paris, Imprimerie Nationale, [1954]. 5 vols. 12″. *fr* 5,500.

Association of British Chemical Manufacturers. Report on the chemical industry 1953: a supplement to the 1949 report. London, 1954. 12p. 11″. 1*s.*

Blank (David M.). The volume of residential construction, 1889–1950. New York, Nat.Bur. Economic Research, 1954. xii, 99p. $1.50. (Tech. Papr. 9.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Bureau of Industrial Statistics, Calcutta. Fourth annual general meeting, 27th August, 1954. Calcutta, 1953. 27p. 11″.

Problems of small engineering industries (statistical survey report). Calcutta, 1953. [vi], 50p. 9¾″.

Burton (J. H.). Local authority finance, accounts and auditing (including financial administration and control.) 3rd. ed. London, Gee, 1954. 304p. 8½″. 25*s*.

Cairncross (A. K.), *editor.* The Scottish economy: a statistical account of Scottish life by members of the staff of Glasgow University. London, C.U.P., 1954. xv, 320p. 9″. 30*s*. (Social and Economic Studies 2.)

Cambridge University. Department of Applied Economics. Inter-county comparisons of the National Accounts and the work of the National Accounts Research Unit of the Organization for European Economic Co-operation; by Richard Stone and Kurt Hansen. *Income & Wealth* (1953), **3**, 41p. 8½″. (Repr. Ser. 73.)

Bibliography of applications of mathematical statistics to economics, *supplement* for 1950; by A. D. Scott. *J. R. Statist. Soc.* A (1953), **116**, 177–185. 9¾″. (Repr.Ser. 74.)

The estimation of quivilant-adult scales from family budgets; S. J. Prais. *Econ. J.* (1953), **63**, 791–810. 9½″. (Repr. Ser. 77.)

Carter (C. F.) & Roy (A. D.). British economic statistics: a report. London, C.U.P., 1954. viii, 188p. 9½″. 21*s*. (N.I.E.S.R. Economic & Social Studies 14.)

Cherrill (Frederick R.). The finger print system at Scotland Yard ... London, H.M.S.O., 1954. [vi], 173p. front., illus. 10¾″. 21*s*.

Cochran (W. G.). Matching in analytical studies. *Amer. J. Publ. Hlth.* (1953), **43**, 684–691. 9¾″.

Cowles Commission for Research in Economics. The determination of many-commodity preference scales by two-commodity comparisons; by Kenneth J. Arrow ... *Metroeconomica* (1952), **4**, 105–115. 9½″. (Cowles Comm. Papr. N.S. 62.)

Alternative conditions for social orderings; by Clifford Hildreth. *Econometrica* (1953), **21**, 81–94. (Cowles Comm. Papr. N.S. 68.)

On the interpretation of Professor Leontief's systems; by Lawrence R. Klein. *Rev. Econ. Stud.* (1953), **20**, [6]p. 9½″. (Cowles Comm. Papr. N.S. 69.)

Capital accumulation and efficient allocation of resources; Edmond Malinvaud. *Econometrica* (1953), **21**, 233–268. 9½″. (Cowles Comm. Papr. N.S. 71.)

A structural approach to the problem of import demand; by Arnold C. Harberger ... *Amer. Econ. Rev.* (1953), **43**, 148–159. 9½″. (Cowles Comm. Papr. N.S. 73.)

Goodwin's nonlinear theory of the business cycle: an electro-analog solution; by R. H. Strotz, J. C. McAnulty and J. B. Naines, *jr. Econometrica* (1953), **21**, 390–411. 9½″. (Cowles Comm Papr. N.S. 74.)

Three papers on recent developments in mathematical economics and econometrics; by Leonid Hurwicz, Tjalling C. Koopmans and Robert H. Strotz. *Amer. Econ. Rev.* (1953), **43**, 384–416. 9½″. (Cowles Comm. Papr. N.S. 75.)

Creamer (Daniel). Capital and output trends in manufacturing industries, 1880–1948. New York, Nat. Bur. Economic Research, 1954. viii, 104p. 9″. $1.50. (Occ. Papr. 41.)

Cox (D. R.). Some simple approximate tests for poisson variates. *Biometrika* (1953), **40**, 354–360. 10¾″.

Some statistical aspects of mixing and blending. *J. Text. Inst.* (1954), **45**, 113–122. 9¾″.

Cox (D. R.) & Smith (Walter L.). A direct proof of a fundamental theorem of renewal theory. *Skand. Aktuar. Tidskr.* (1953). 139–150. 9¼″.

David (H. A.). Further applications of range to the analysis of variance. *Biometrika* (1951), **38**, 393–409. 10¾″.

The power function of some tests based on range. *Biometrika* (1953), **40**, 347–353. 10¾″.

An operational method for the derivation of relations between moments and cumulants. *Metron* (1952), **16**, 3–4. 9p. 9½″.

Upper 5 and 1% points of the maximum F-ratio. *Biometrika* (1952), **39**, 422–424. 10¾″.

Dodson (R. Warwick). An introduction to cost accountancy ... Vol. I. London, Gee, 1954. 319p. fol. tabs. 8½″. 35*s*.

Eyraud (Henri). Leçons sur la théorie des ensembles ... I. Le théorème du continu. II. La divisibilité Asymptotique. Lyon, Institut Mathematiques, 1952–53. 4 vols. 10¾″. (Cours de Mathématique Superieures de la Faculté des Sciences de Lyon.)

Finney (D. J.). Experimental tests of mixed farming in India. *Indian J. Agric. Sci.* (1953), **23**, 269–281. 9¾″.

Response curves and the planning of experiments. *Indian J. Agric. Sci.* (1953), **23**, 167–186. 9¾″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Ford (P.) & Thomas (C. J.). Shops and planning: the second report of the Southampton survey. Oxford, Blackwell, 1953. 54p. 8½″. 4*s*.

Housing targets: the third report of the Southampton survey. Oxford, Blackwell, 1953. 56p. 8½″. 4*s*.

Forsythe (George E.). Solving linear equations can be interesting. *Bull. Amer. Math. Soc.* (1953) **59**, 299–329. 9½″.

Fryer (H. C.). Elements of statistics. New York, Wiley, (London, Chapman & Hall.), 1954. viii, 262p. 9″. 38*s*.

Goldsmith (Raymond W.). The share of financial intermediaries in national wealth assets, 1900–1949. New York, Nat. Bur. Economic Research, 1954. x, 120p. 9″. $1.50. (Occ. Papr. 42.)

Hammersley (J. M.). Markovian walks on crystals. *Compos. Math.* (1953), **11**, 171–186. 9¼″.

Harris (Arthur) & Norris (Vera). Changes in duration of stay of mental hospital patients suffering from functional psychoses during the past 20 years. *J. Ment. Sci.* (1954), **100**, 241–249. 9¾″.

Hegeland (Hugo). The multiplier theory. Lund, C. W. K. Gleerup, 1954. xi, 261p. 9¼″, (Lund Social Science Studies 9.)

Heidenwag (Hans). Das Mietzinsniveau in Linz 1954. *Stat. Jahr. Stadt Linz.* 1953. [1954.] [ii] 12 [15] l. 11½″.

International Statistical Institute. International Statistical Conference, December, 1951. India. *Bull. Int. Statist. Inst.* (1951), **33**, II, III, IV. 3 vols. 9¾″.

Irvine (A. G.). Marketing research and management. London, Macdonald & Evans, 1954. ix, 275p. 8½″. 30*s*.

Knight (Sir Henry). Food administration in India, 1939–47. Stanford Univ. Press. London, Geoffrey Cumberlege, 1954. xiii, 323p. 9″. 60*s*. (Food, Agriculture & World War II.)

Kuznets (Simon). Economic change: selected essays in business cycles, national income and economic growth. London, Heinemann, 1954. viii, 333p. 8½″. 15*s*.

Langer (Rudolph E.). A first course in ordinary differential equations. New York, Wiley. (London, Chapman & Hall.), 1954. xii, 249p. 9″. 36*s*.

Lehmann (E. L.) & Stein (C. M.). The admissibility of certain invariant statistical tests involving a translation parameter. *Ann. Math. Statist.* (1953), **24**, 473–479. 10″.

Leontief (Wassily). Domestic production and foreign trade; the American capital position re-examined. *Proc. Amer. Phil. Soc.* (1953), **97**, 332–349. 10½″.

London School of Economics and Political Science. Division of Research Techniques. The estimation and comparison of strengths of association in contingency tables; by A. Stuart ... *Biometrika* (1953), **40**, 105–110. 10¼″. (Repr. Ser. 21.)

Marcus (Edward). Canada and the international business cycle 1927–1939. New York, Bookman Associates, 1954. [vi], vi, 211p. 8½″. $3.75.

Market Research Society. Readership surveys: a comparative study. London, Market Research Society, 1954. iv, 20p. 9¾″. 2*s*. 6*d*. (Publ. Market Res. Soc. 1.)

Martin (W. J.). Mortality and fog in London. *Med. Offr.* (1953), **90**, 233–234. 12″.

The recent trends of infectious diseases in childhood. *Brit. Med. J.* (1954). 909–912. 11″.

Meier (Paul). Variance of a weighted mean. *Biometrics* (1953), **9**, 59–73. 9¼″.

Mitchell (A. R.). Round-off errors in the solution of the heat conduction equation by relaxation methods. *Appl. Sci. Res. Hague, A.* (1953), **4**, 109–119. 9½″.

Nair (K. R.). Statistical methods in forest research. *Indian For.* (1953), **79**, 383–389. 9¾″. (Indian For. Leafl. 134.)

National Bureau of Economic Research. Regularization of business investment: a conference of the Universities National Bureau Committee for Economic Research. Princeton, published for the N.B.E.R. by the Princeton University Press, 1954. xxvi, 513p. 9″. $8. (N.B.E.R. Special Conference Series.)

Netherlands Central Planbureau. De besparingen van de Ned. volkshuishoulding voor en na de oorlog; door J. C. Wijnmaalen. The Hague, Central Planning Bureau, 1954. [6]p. 9¼″. (Repr. 26.)

Central economic plan, 1954. The Hague, Central Planning Bureau, 1954. 46p. 9½″.

Neyman (Jerzy) & Scott (Elizabeth L.). Frequency of separation and of interlocking of clusters of galaxies, *Proc. Nat. Acad. Sci. Wash.* (1953), **39**, 737–743. 10¼″.

Norris (Vera). Health of the school child. *Brit. J. Soc. Med.* (1951), **5**, 145–161. 9¾″.

The mental hospital service and its future needs; a statistical appraisal. *Lancet* (1952). 8p. 8½″.

Review of 8,000 cases of pneumonia admitted to Dudley Road Hospital, Birmingham (1934–38 and 1944–48.) *Brit. J. Prev. Soc. Med.* (1953), **7**, 112–172. 9¾″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Rôle of statistics in regional hospital planning: with special reference to the Birmingham Hospital Region. *Brit. Med. J.* (1952), i, p.129. 13p. 8½″.

North Carolina Univ. of Institute of Statistics. On a heuristic method of test construction and its use in multivariate analysis, by S. N. Roy. *Ann. Math. Statist.* (1953), **24**, 220–238. 9¾″. (Repr. Ser. 38.)

The analysis of variation in a natural population of lady beetles; by Frank M. Sturtevant, *jr.* Lyle D. Calvin and Orlando Park ... *Biometrics* (1953), **9**, 117–126. 9″. (Repr. Ser. 39.)

Proper planning reduces research errors; by R. L. Anderson. *J. Fm. Econ.* (1953), **35**, 572–581. 8¾″. (Rep. Ser. 41.)

The design, conduct and interpretation of grazing trials on cultivated and improved pastures; C. O. Mott ... & H. L. Lucas ... *6th Int. Grassld. Congr.* [6] p. 9¼″. (Repr. Ser. 42.)

Simultaneous confidence interval estimated; by S. N. Roy and R. C. Bose ... *Ann. Math. Statist.* (1953), **24**, 513–536. 9¾″. (Repr. Ser. 43.)

A sampling investigation of the efficiency of weighting inversely as the estimated variance; William G. Cochran and Sarah Porter Carroll ... *Biometrics* (1953), **9**, 447–459. 9″. (Repr. Ser. 44.)

The analysis of errors in assaying fecal androgens in the dairy cow; by A. Grandage, R. B. Casady, H. L. Lucas ... *J. Dairy Sci.* (1954), **27**, 72–80. 9¾″. (Repr. Ser. 45.)

Recent advances in finding best operating conditions; by R. L. Anderson. *J. Amer. Statist. Soc.* (1953), **48**, 789–798. 9″. (Repr. Ser. 46.)

The problem of autocorrelation in regression analysis; by R. L. Anderson ... *J. Amer. Statist. Soc.* (1954), **49**, 113–129. 9¼″. (Repr. Ser. 47.)

Oliveira (J. Tiago de). Distribution-free methods for the statistical analysis in geophysics. Porto, Tipografia Mendonça Limitada, 1952. 8p. 10¼″. (Publ. Sindicato Nac. Engenheiros Geografos. 3.)

A note on a special case on inverse binomial sampling. *Rev. Fac. Sci., Lisboa.* A. (1952), **2**, 111–114. 9¼″.

Sur le calcul des moments de la réciproque d'une variable aléatoire positive de Bernoulli et Poisson. *Ann. Fac. Sci., Porto.* (1952), **26**, 8p. 9¼″.

Tests for the equality of proportions in a multinomial population. *Rev. Fac. Sic., Lisboa* (1952), **2**, 197–200. 9″.

Oswald (Neville C.), Harold (James T.) & Martin (W. J.). Clinical patterns of chronic bronchitis. *Lancet* (1953), September 26. 15p. 8½″.

Pakistan Statistical Conference, 1950. Proceedings of the first Pakistan Statistical Conference, held in the University of the Panjab. [Lahore], 1950. 93p. photos, diagrs. 10½″.

1953. Proceedings of the second Pakistan Statistical Conference held in the University of Dacca. [Lahore], 1953. 111p. diagrs. 9¾″.

Pearson (E. S.) & Hartley (H. O.), *editors.* Biometrika tables for statisticians, Vol. I. Cambridge, published for the Biometrika Trustees at the University Press, 1954. xiv, 238p. 11″. 25*s.*

Prest (A. R.). Consumers' expenditure in the United Kingdom 1900–1919. London, C.U.P., 1954. xiii, 196p. 12½″ × 10″. 42*s.* (Studies in the National Income and Expenditure of the United Kingdom 3.)

Rao (C. Radhakrishna). A simplified approach to factorial experiments and the punched card technique in the construction and analysis of designs. *Bull. Int. Statist. Inst.* (1951), **33**, 1–28. 9¾″.

Richardson (Lewis F.). The submissiveness of nations. *Brit. J. Statist. Psychol.* (1953), **6**, 77–90. 9¾″.

Rodgers (John) & Mason (J. I.). International statistics for governments and business. *Incorp. Statist.* (1953), **4**, 179–195.

Roose (Kenneth D.). The economics of recession and revival: an interpretation of 1937–38. New Haven, Yale University Press, (London, Geoffrey Cumberlege.), 1954. xi, 280p. 9¼″. $4. (Yale Studies in Economics 2.)

Salter (W. E. G.). The measurement of Australian production: an examination of the problems. Nedlands, University of Western Australia Press, 1954. [iv], iv, 63p. 9¾″. 5*s.* (Univ. Western Australia. Dept. Econ. Ser. A. 3.)

Samuel (Herbert Louis, 1st Viscount). A century's changes of outlook: the Hibbert Centenary Lecture. London, C.U.P., 1953. 22p. 7¼″. 2*s.* 6*d.*

Sartwell (Philip E.) & Merrell (Margaret). Influence of the dynamic character of chronic disease on the interpretation of morbidity rates. *Amer. J. Publ. Hlth.* (1952), **42**, 579–584. 10″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Schwerdt (Carlton) & Merrell (Margaret). Precision of measurement of Lansing virus infectivity in cotton rats. *Amer. J. Hyg.* (1952), **55**, 268–275. 10″.

Smith (Cedric A. B.). Biomathematics: the principles of mathematics for students of biological science; being the 3rd edition and a rewritten version of the work by the late W. M. Feldman ... London, Griffin, 1954. xv, 712p. 8¾″. 80*s*.

Smith (Walter L.). A frequency-function form of the central limit theorem. *Proc. Camb. Phil. Soc.* (1953), **49**, 462–472. 10¼″.

On the distribution of queueing times. *Proc. Camb. Phil. Soc.* (1953), **49**, 449–461. 10¼″.

Society of Incorporated Accountants & Auditors Research Committee. Register of International research in accounting: with titles of subjects, names of persons engaged in research and names of sponsoring professional bodies, universities or institutions. London, published for the Incorporated Accountants' Research Committee by the Oxford University Press, 1954. vii, 68p. 8½″. 7*s*. 6*d*.

Stearman (Roebert L.) *and others.* A statistical estimation of variation encountered in studying dispersion of radioactive phosphorus in embryonated chicken eggs; [by] Roebert L. Stearman, Thomas G. Ward and R. Ann Webster ... *Arch. Biochm. Biophys.* (1953), **45**, 397–410. 9″.

Use of a "Components of variance" technique in biological experimentation; by Roebert L. Stearman, Thomas G. Ward and R. Ann Webster. *Amer. J. Hyg.* (1953), **58**, 340–351. 10″.

Stevens (W. L.). Tables of the angular transformation. *Biometrika* (1953), **40**, 70–73. 10¾″.

Strauss (E.). Sir William Petty: portrait of a genius. London, Bodley Head, 1954. 260p. front. 8½″. 25*s*.

Struik (Dirk J.). A concise history of mathematics. London, Bell, 1954. xix, 299p. illus. 7½″. 14*s*.

Sukhatme (Pandurang V.). Sampling theory of surveys with applications. New Delhi, Indian Society of Agricultural Statistics. Ames, Iowa U.S.A., State College Press, [1953.]. xxix, 491p. 9½″.

Sutton (O. G.). Mathematics in action. London, Bell, 1954. viii, 226p. illus. 8¾″. 16*s*.

Swerling (Boris C.). Buffer stocks and international commodity problems. *Econ. J.* (1953), **63**, 778–790. 9¾″.

Taylor (Wallis). The changing pattern of mortality in England and Wales. *Brit. J. Prev. Soc. Med.* (1954), **8**, 1–9p. 9¾″.

Thomas (Brinley). Migration and economic growth: a study of Great Britain and the Atlantic economy. London, C.U.P., 1954. xxv, 362p. 9¼″. 42*s*. (N.I.E.S.R. Economic & Social Studies 12.)

Timoshenko (Vladimir). Agriculture in the Soviet spotlight. *For. Affr.* (1954), 15p. 10″.

New Soviet economic plan: its agricultural aspects. *J. Polit. Econ.* (1953), **61**, 489–508. 9½″.

Tin Research Institute. The properties of tin. Greenford, Middx., Tin Research Institute, 1954. 55p. 9¾″. 2*s*. 6*d*.

Tuck (R. H.). An essay on the economic theory of rank. Oxford, Blackwell, 1954. [iv], 52p. 8½″. 7*s*. 6*d*.

Vergotini (M. de) *and others.* Studi sulle relazioni statistiche; M. de Vergottini, P. Battara, V. Amato, R. Mogno. Roma, Società Italiana Economia, Demografia e Statistica, 1952–3. 53, [2]p. 9½″. *L* 600. (Studi e Monografie 6.)

Vermetten (J. B.) & Plantinga (Joh). The elasticity of substitution of gas with respect to other fuels in the United States. *Rev. Econ. Statist.* (1953), **25**, 140–143. 11″.

Westoff (Charles F.) & Kiser (Clyde V.). Social and economic factors affecting fertility: XXI. An empirical re-examination and intercorrelation of selected hypothesis factors. *Milbank Mem. Fd. Quart.* (1953), **21**, 953–967. 9½″.

Williams (E. J.). A method of analysis for double classifications. *Aust. J. Appl. Sci.* (1953), **4**, 357–370. 9¼″.

Wolfenden (Hugh H.). Population statistics and their compilation. rev. ed. ... with an appendix on "Some theory in the sampling of human populations"; by W. Edwards Deming ... Chicago, published for the Society of Actuaries by the University of Chicago Press, 1954. xxiii, 258p. 9″. $7.50.

Working (Holbrook). Hedging reconsidered. *J. Farm. Econ.* (1953), **35**, 544–561. 9″.

Price supports and the effectiveness of hedging. *J. Farm. Econ.* (1953), **35**, 811–818. 9″.

Yates (F.). Principles governing the amount of experimentation in development work. *Nature* (1952), **170**, 7p. 8¼″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REGISTRATION OF THE UNITED KINGDOM AND EIRE

No. I.—ENGLAND AND WALES

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1949–1953 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age; rate per* 1,000 *related Live Births. Stillbirths per* 1,000 *births).*

Years	1949		1950		1951		1952		1953†	
Estimated Mid-year Popn. in thousands‡	43,785		43,830		43,800§		43,940		44,090	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live births	731,172	*16·7*	691,760	*15·8*	679,689	*15·5*	673,286	*15·3*	682,007	*15·5*
Stillbirths	16,977	*22·7*	16,055	*22·7*	16,019	*23·0*	15,636	*22·7*	15,630	*22·4*
Deaths[1]	510,736	*11·7*	510,301	*11·6*	549,380	*12·5*	497,484	*11·3*	503,403	*11·4*
Marriages	375,041	*8·6*	358,490	*8·2*	360,624	*8·2*	349,308	*8·0*	344,488	*7·8*
Infant Mortality	23,882	*32·4*	20,817	*29·6*	20,224	*29·7*	18,555	*27·6*	18,180	*26·8*
Effective Reproductive Rate[2]	*1·023*		*0·986*		*0·969*		*0·98*		*1·03*	
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–March	186,611	*17·3*	180,130	*16·7*	176,047	*16·3*	173,338	*15·9*	171,705	*15·8*
Apr.–June	192,038	*17·6*	181,343	*16·6*	181,614	*16·6*	174,159	*15·9*	179,464	*16·4*
July–Sept.	183,221	*16·6*	170,087	*15·4*	168,033	*15·2*	168,030	*15·2*	172,976	*15·6*
Oct.–Dec.	169,302	*15·3*	160,200	*14·5*	153,995	*13·9*	157,759	*14·3*	157,862	*14·2*
	Stillbirths									
Jan.–March	4,446	*23·3*	4,238	*23·0*	4,259	*23·6*	4,174	*23·5*	3,957	*22·5*
Apr.–June	4,496	*22·9*	4,172	*22·5*	4,196	*22·6*	4,004	*22·5*	4,199	*22·9*
July–Sept.	4,118	*22·0*	3,919	*22·5*	3,752	*21·8*	3,714	*21·6*	3,709	*21·0*
Oct.–Dec.	3,917	*22·6*	3,726	*22·7*	3,812	*24·2*	3,755	*23·2*	3,764	*23·3*
	Deaths[1] (excluding Stillbirths)									
Jan.–March	161,265	*14·9*	151,284	*14·0*	205,878	*19·1*	146,948	*13·5*	171,268	*15·8*
April–June	119,972	*11·0*	120,791	*11·1*	121,683	*11·1*	115,369	*10·6*	114,538	*10·5*
July–Sept.	101,190	*9·2*	102,867	*9·3*	100,057	*9·1*	98,613	*8·9*	98,588	*8·9*
Oct.–Dec.	128,309	*11·6*	135,359	*12·3*	121,762	*11·0*	136,554	*12·4*	119,009	*10·7*
	Marriages									
Jan.–March	81,774	*7·6*	86,900	*8·0*	109,567	*10·2*	106,629	*9·8*	93,438	*8·6*
April–June	95,565	*8·8*	80,726	*7·4*	66,382	*6·1*	69,489	*6·4*	77,040	*7·1*
July–Sept.	114,405	*10·4*	114,828	*10·4*	111,312	*10·1*	103,411	*9·4*	105,475	*9·5*
Oct.–Dec.	83,297	*7·6*	76,036	*6·9*	73,363	*6·7*	69,779	*6·3*	68,535	*6·2*
	Infant Mortality									
Jan.–March	7,532	*40·4*	6,575	*36·8*	6,572	*38·4*	5,629	*33·6*	5,645	*33·8*
April–June	5,758	*30·3*	5,034	*27·8*	5,066	*28·6*	4,332	*25·1*	4,441	*25·6*
July–Sept.	4,915	*26·5*	4,176	*23·9*	4,003	*23·4*	3,863	*22·8*	3,832	*22·2*
Oct.–Dec.	5,677	*32·3*	5,032	*30·0*	4,583	*28·5*	4,731	*29·0*	4,262	*26·1*

* All rates are based on the estimated population as at the middle of the corresponding year.
† Provisional figures.
‡ For 1949, total populations, i.e. including members of the Armed Forces stationed at home and abroad. For 1950–53, home populations, i.e. including members of the Armed Forces stationed within England and Wales.
§ Examination in the light of the Census data indicated that the estimates of preceding years had become inflated and that, but for this, a population increase of some 46,000 would have been recorded for the year 1950/51 instead of the decline of 30,000 shown above.
[1] Including deaths of non-civilians registered in England and Wales.
[2] Based not upon current, but upon estimated future mortality.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No. II.—SCOTLAND

BIRTHS, DEATHS, *and* MARRIAGES *registered in the Calendar years* 1949–1953 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age, rate per* 1,000 *Live Births; Stillbirths per* 1,000 *Births).*

Years	1949		1950		1951		1952		1953†	
Estimated Mid-year Popn. in thousands‡	5,175		5,175		5,114		5,114		5,118	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	95,674	*18·5*	92,530	*17·9*	90,639	*17·7*	90,442	*17·7*	90,909	*17·8*
Stillbirths	2,666	*27*	2,557	*27*	2,479	*27*	2,430	*26*	2,307	*25*
Deaths	63,488	*12·3*	63,996	*12·4*	65,778	*12·9*	61,510	*12·0*	58,878	*11·5*
Marriages	41,708	*8·1*	40,459	*7·8*	41,383	*8·1*	41,163	*8·0*	40,916	*8·0*
Infant Mortality	3,961	*41*	3,569	*39*	3,391	*37*	3,181	*35*	2,801	*31*
Quarters	**Live Births in the Quarters of each Calendar Years**									
Jan.–March	24,230	*19·0*	23,542	*18·5*	23,625	*18·8*	22,892	*18·0*	22,860	*18·1*
April–June	25,424	*19·7*	24,646	*19·1*	24,310	*19·1*	23,531	*18·5*	23,791	*18·7*
July–Sept.	23,324	*17·9*	22,498	*17·3*	21,932	*17·0*	22,161	*17·3*	22,165	*17·2*
Oct.–Dec.	22,696	*17·4*	21,844	*16·8*	20,772	*16·1*	21,838	*17·0*	22,093	*17·1*
	Stillbirths									
Jan.–March	707	*28*	673	*28*	657	*27*	677	*29*	601	*26*
April–June	710	*27*	659	*26*	658	*26*	598	*25*	586	*24*
July–Sept.	642	*27*	627	*27*	575	*26*	541	*24*	561	*25*
Oct.–Dec.	607	*26*	598	*27*	589	*28*	614	*27*	559	*25*
	Deaths (excluding Stillbirths)									
Jan.–March	19,222	*15·1*	18,647	*14·7*	22,428	*17·8*	18,394	*14·5*	17,264	*13·7*
April–June	15,274	*11·8*	14,986	*11·6*	15,442	*12·1*	14,270	*11·2*	14,345	*11·2*
July–Sept.	13,119	*10·1*	13,341	*10·2*	13,104	*10·2*	12,813	*10·0*	12,722	*9·9*
Oct.–Dec.	15,873	*12·2*	17,022	*13·1*	14,804	*11·5*	16,033	*12·5*	14,547	*11·3*
	Marriages									
Jan.–March	10,638	*8·4*	11,111	*8·7*	11,566	*9·2*	12,423	*9·8*	12,091	*9·6*
April–June	9,209	*7·1*	8,680	*6·7*	8,963	*7·0*	8,158	*6·4*	8,213	*6·4*
July–Sept	12,786	*9·8*	11,847	*9·1*	12,054	*9·4*	11,896	*9·3*	12,070	*9·4*
Oct.–Dec.	9,075	*7·0*	8,821	*6·8*	8,800	*6·8*	8,686	*6·8*	8,542	*6·6*
	Infant Mortality									
Jan.–March	1,225	*51*	1,080	*46*	1,088	*46*	872	*38*	776	*34*
April–June	913	*36*	841	*34*	850	*35*	801	*34*	696	*29*
July–Sept.	823	*35*	737	*33*	698	*32*	663	*30*	614	*28*
Oct.–Dec.	1,000	*44*	911	*42*	755	*36*	845	*39*	715	*32*

* Death Rates for 1949 are based on all deaths registered in Scotland, related to the total population.
Death Rates for 1950–53 are based on all deaths registered in Scotland, related to the home population.

† Provisional figures.

‡ 1949 Estimated mid-year total population (including persons serving outside Scotland with the Mercantile Marine and, under the National Service Act, H.M. Forces).
1950–53 Estimated mid-year home population (including members of the Mercantile Marine at home and abroad.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No. III.—NORTHERN IRELAND

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1949–1953 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age, rate per* 1,000 *Live Births).*

Years	1949		1950		1951		1952[2]		1953[2]	
Estimated Mid-year Popn. in thousands*	1,360		1,369		1,373		1,375		1,384	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live births	29,106	*21·4*	28,794	*21·0*	28,477	*20·7*	28,760	*20·9*	28984	*20.9*
Stillbirths[1]					Not registered					
Deaths‡	15,652	*11·5*	15,839	*11·6*	17,628	*12·8*	14,812	*10·8*	14,813	*10·7*
Marriages	9,216	*6·8*	9,084	*6·6*	9,414	*6·9*	9,300	*6·8*	9,416	*6·8*
Infant Mortality	1,317	*45*	1,166	*40*	1,173	*41*	1,117	*39*	1,090	*38*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–March	7,379	*21·8*	7,275	*21·3*	7,254	*21·2*	7,095	*20·8*	7,212	*21·3*
April–June	7,764	*22·9*	7,725	*22·5*	7,769	*22·6*	7,589	*22·2*	7,902	*22·9*
July–Sept.	7,193	*21·2*	7,090	*20·7*	7,089	*20·5*	7,215	*20·9*	7,254	*20·8*
Oct.–Dec.	6,770	*19·9*	6,704	*19·5*	6,365	*18·4*	6,861	*19·9*	6,616	*19·0*
	Deaths‡ (excluding Stillbirths)									
Jan.–March	4,758	*14·0*	4,551	*13·3*	6,971	*20·4*	4,450	*13·0*	4,541	*13·4*
April–June	3,812	*11·2*	3,925	*11·4*	3,951	*11·5*	3,671	*10·7*	3,734	*10·8*
July–Sept.	3,228	*9·5*	3,222	*9·4*	3,211	*9·3*	3,093	*9·0*	3,075	*8·8*
Oct.–Dec.	3,854	*11·3*	4,141	*12·1*	3,495	*10·1*	3,598	*10·4*	3,463	*9·9*
	Marriages									
Jan.–March	1,975	*5·8*	2,055	*6·0*	2,210	*6·5*	2,272	*6·7*	2,022	*6·0*
April–June	2,287	*6·7*	2,081	*6·1*	1,958	*5·7*	2,099	*6·1*	2,288	*6·6*
July–Sept.	2,862	*8·4*	3,066	*9·0*	3,174	*9·0*	2,988	*8·7*	3,235	*9·2*
Oct.–Dec.	2,092	*6·1*	1,882	*5·5*	2,072	*5·9*	1,941	*5·6*	1,871	*5·4*
	Infant Mortality									
Jan.–March	402	*55*	323	*44*	371	*51*	317	*45*	332	*46*
April–June	297	*38*	284	*37*	292	*38*	288	*38*	294	*37*
July–Sept.	309	*43*	253	*36*	255	*36*	232	*32*	225	*31*
Oct.–Dec.	309	*46*	305	*45*	255	*40*	280	*41*	239	*36*

* For 1949–50 rates are based on civilian population only; for 1951–53 they are based on "home" population. (Civilians and members of H.M. Forces stationed in Northern Ireland).
‡ For 1949–50 civilian deaths only; for 1951–53, total deaths registered.
[1] Stillbirths are not registered in Northern Ireland. The birth of one living child and one stillborn, or one living child and two stillborn, is counted as one birth.
[2] By courtesy of the Registrar-General for Northern Ireland.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No. IV.—EIRE

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1949–1953 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age, rate per* 1,000 *Live Births).*

Years	1949		1950		1951†		1952†		1953†	
Estimated Mid-year Popn. in thousands	2,981		2,969		2,959		2,948		2,942	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Livebirths	64,153	*21·5*	63,565	*21·4*	62,587	*21·2*	64,226	*21·8*	62,202	*21·1*
Stillbirths‡					Not registered					
Deaths	38,062	*12·7*	37,741	*12·7*	42,412	*14·3*	35,155	*11·9*	34,585	*11·8*
Marriages	16,009	*5·4*	16,018	*5·4*	15,860	*5·4*	15,769	*5·3*	15,603	*5·3*
Infant Mortality	3,415	*53*	2,922	*46*	2,840	*45*	2,646	*41*	2,448	*39*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–March	16,388	*21·9*	15,843	*21·3*	15,669	*20·9*	16,090	*21·8*	15,692	*21·3*
April–June	16,774	*22·4*	17,172	*23·1*	16,908	*22·5*	17,524	*23·8*	16,761	*22·8*
July–Sept.	16,519	*22·1*	15,960	*21·5*	16,204	*21·9*	15,845	*21·5*	15,702	*21·3*
Oct.–Dec.	14,472	*19·4*	14,590	*19·7*	13,806	*18·7*	14,767	*20·0*	14,047	*19·1*
	Deaths (excluding Stillbirths)									
Jan.–March	11,010	*14·7*	11,172	*15·1*	16,600	*22·1*	10,658	*14·4*	10,555	*14·3*
April–June	9,920	*13·3*	9,687	*13·1*	10,220	*13·6*	8,731	*11·8*	8,926	*12·1*
July–Sept.	8,082	*10·8*	7,690	*10·4*	7,653	*10·3*	7,267	*9·9*	7,129	*9·7*
Oct.–Dec.	9,050	*12·1*	9,192	*12·4*	7,939	*10·7*	8,499	*11·5*	7,975	*10·8*
	Marriages									
Jan.–March	3,622	*4·8*	3,429	*4·6*	3,327	*4·4*	3,441	*4·7*	2,935	*4·0*
April–June	3,620	*4·8*	3,813	*5·1*	3,854	*5·2*	3,692	*5·0*	3,771	*5·1*
July–Sept.	5,186	*6·9*	5,410	*7·3*	5,482	*7·4*	5,207	*7·1*	5,435	*7·4*
Oct.–Dec.	3,581	*4·8*	3,366	*4·5*	3,197	*4·3*	3,429	*4·7*	3,462	*4·7*
	Infant Mortality									
Jan.–March	928	*57*	962	*61*	916	*58*	877	*55*	698	*44*
April–June	856	*51*	778	*45*	773	*46*	611	*35*	682	*41*
July–Sept.	749	*45*	584	*37*	589	*36*	567	*36*	514	*33*
Oct.–Dec.	882	*61*	598	*41*	562	*41*	591	*40*	554	*39*

* Rates are based on the total estimated population as at the middle of the corresponding year.
† Provisional figures.
‡ Stillbirths are not registered in Eire. The births of one living and one stillborn, or of one living child and two stillborn, are counted as one birth.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Vol. 117.] [Part IV

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART IV, 1954.

Callbacks and Clustering in Sample Surveys: an Experimental Study

By J. Durbin and A. Stuart

Division of Research Techniques, London School of Economics

[Read before the Royal Statistical Society, May 19th, 1954, Mr. E. C. Fieller, Vice-President, in the Chair]

1. *Introduction*

1.1. For selecting samples of human populations the survey practitioner may use either *random sampling* or some non-random method such as *quota sampling*. The advantages of the former method are nowadays well understood: theoretically it is objective, unbiased, and the sampling errors can be estimated from the results of the survey. In practice the realization of these advantages to the fullest extent possible involves persistent recalling on those members of the sample not found at home. This process is costly and inconvenient, and various procedures have therefore been suggested for reducing the total number of calls. One of the purposes of the research described in this paper was to investigate the performance of these procedures, the standard of comparison being the results obtained by persistent recalling. Biases contained in the latter, however important in practice, have not been considered. In addition we investigated the interviewing costs of different methods of selecting samples from the Electoral Register, and the sampling variances of estimates based on these methods. Finally, we were able to compare the results obtained by different interviewers working under similar conditions.

This study, which is one of a series of experimental studies of survey problems, was planned by the Survey Research Committee consisting of representatives of the British Broadcasting Corporation Audience Research Department, the British Institute of Public Opinion (B.I.P.O.), the British Market Research Bureau (B.M.R.B.), The Government Social Survey, Market Information Services (M.I.S.), Research Services (R.S.) and the Division of Research Techniques. The fieldwork was done by organizations B.I.P.O., B.M.R.B., M.I.S. and R.S. We should like to thank Dr. M. Abrams, Mr. T. Cauter, Dr. H. Durant, Mr. F. Edwards, Mr. B. P. Emmett, Mr. P. G. Gray, Mr. W. Gregory, Mr. H. Henry, Mr. L. Moss, Mr. P. G. L. Parkinson, Mr. D. H. Pickard and Mr. L. F. Smith and their organizations for their co-operation at all stages of the research. The Director of the Division, Professor M. G. Kendall, and our colleague Mr. C. A. Moser, have given us much help, and Mr. R. I. Cole (Research Assistant), Miss J. Grahame and Mrs. M. Howard (Computers) and Miss R. Baines (Secretary) have carried out much of the hard work of organization and analysis.

The presentation of the material and the inferences drawn from it in this paper remain the responsibility of ourselves alone.

1.2. *Non-response.* The term "non-response" will in this paper be understood to cover failure to obtain an interview for one of two reasons:

(i) the informant is absent from home for a short period;

(ii) the informant is indisposed or too busy at the time of call but is willing to be interviewed later.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

We are thus confining ourselves to cases in which it would be at least possible for a successful interview to be made by recalling within the field work period. It is not denied that refusals, removals, illness and absence for a long period are important categories of non-achievement—they have been separated off simply because they are due to factors which cannot easily be dealt with in the field and which consequently would be difficult to investigate experimentally. On the other hand, the causes (i) and (ii) above can be dealt with by persistent recalling, or by the making of appointments by the interviewer.

Bearing in mind this narrow definition of the term "non-response" it will be seen that the object of our experiment was a limited one. We were not concerned with the investigation of biases arising from the fact that, even with an unlimited number of callbacks, an appreciable proportion of a human population is generally not obtainable by the best of samples. We restricted ourselves to the objective of investigating how far methods of dealing with non-response which have been recommended, or seem interesting and practical, can be relied on to achieve the results which persistent recalling would achieve. Our standard of comparison is therefore the result obtained by persistent recalling, however deficient this may itself be in particular cases.

From a theoretical point of view, this might be regarded as putting the cart before the horse: why measure up to a possibly defective standard? Survey practitioners, on the other hand, would be very glad to know that a particular method gives results close to those obtainable by unlimited recalls. If recalls could be made without cost there would be no difficulty; the investigator would continue calling until the interview had been obtained. In practice, complete recalling is usually ruled out on grounds of cost and time and one of a number of other methods of dealing with the problem is adopted.

Methods which have in the past been proposed for dealing with non-response are:

(1) Recalling up to a limited number of calls.

Any method based on recalls tends to be regarded as a high-cost method by most practical workers, possibly owing to a misunderstanding of the way in which the cost should be allocated to the interviews at the successive calls. It is often supposed that, assuming the cost of making a call to be constant, an interview obtained at the second call must cost twice as much as an interview obtained at the first, since two calls have been made for the former interview and only one for the latter. However, if the probability of success is the same at each call, the effective cost per interview obtained at the second call will be precisely the same as at the first. The reason is that it is impossible to know in advance which particular calls will be successful. Consequently, the effective cost of the successes at the first call is the total cost of all first calls, whether successful or not. Similarly, the effective cost of the successful second calls is the total cost of all second calls made, and so on. If the probability of a success at the second call is higher than at the first, the effective cost of a successful second call may actually be lower than at the first. Even if the cost of making a second call is higher than the cost of making a first call, the rise may not be sufficient to offset the effect of the greater probability of success. The result is that it may be cheaper in terms of cost per interview to make recalls than to confine the interviewing to first calls; at any rate the rise in costs may be less than is often supposed.

In this country the number of calls on any one individual is usually limited to three. See, for example, Gray and Corlett (1950).

(2) Complete recalling on a sub sample of those not obtained at the first attempt.

This method was suggested for dealing with non-respondents to postal enquiries by Hansen and Hurwitz (1946) who obtained an expression for the optimum subsampling ratio. Although the method has been recommended by some writers for the sub sampling of respondents not available at the first call, a theoretical treatment given elsewhere (Durbin, 1953) shows that when applied to this problem the method is unlikely to result in worth while gains. Consequently, it will not be discussed further in this paper.

(3) One call only on each person, the results being weighted by the reciprocal of the frequencies with which those interviewed are at home. The method is due to Hartley (1946) and Politz and Simmons (1949).

The population sampled may be regarded as stratified according to individuals' probabilities of being found at home by the investigator. If these probabilities were known and if results after one call were weighted by the reciprocals of these probabilities, bias due to not-at-homes

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

would be eliminated apart from that due to the small section of the population which is never at home and which is therefore unobtainable by any method based on home interviews. In practice, these probabilities must be estimated by special questions asked of those found at home.

The method is theoretically capable of eliminating the bias of a sample based on a single call, and if the replies to a particular question are highly correlated with the probability of being at home, and the cost of interviews obtained on recall would be higher than of those obtained on the first call, it should be more effcient than the method of unlimited recalls.

The difficulty in practice is to get satisfactory estimates of the probabilities of respondents' being at home. Politz and Simmons assume that interviewing is carried out during the evening and suggest that the investigators ask the respondent whether he was at home at the time of interview on each of five previous nights (excluding Sunday). The frequency with which the respondent was at home estimates the required probability. This procedure will only be satisfactory if the calls are spread uniformly over the evenings of the week, if the respondents are prepared to answer the questions and if the answers are correct.

In addition we have considered:

(4) Replacement of those not available after a given number of calls by a quota sample based, as far as possible, on information collected by the investigator at the unsuccessful calls.

This method has the merit that the quota samples, consisting largely of interviews outside the home, may be expected to pick up the "not-at-home" type of respondent. On the other hand, quota samples can give rise to their own bias and estimates of their sampling variance cannot ordinarily be calculated.

The criteria by which these methods should be compared are cost, bias and variance. A useful composite index of efficiency would be the reciprocal of the product of cost and mean square error (i.e., bias^2 + sampling variance) and an interesting theoretical study from this standpoint has recently been made by Deming (1953). In contrast, our approach has been empirical, with the object of comparing the results obtained by the various methods on different types of question, making cost and variance comparisons where possible.

1.3. *Clustering.* In addition to non-response we have investigated three different types* of clustering the interviews on the ground. One would expect that if the addresses of those interviewed were clustered into small areas, instead of being spread uniformly over an entire town, interviewing costs would be substantially reduced. On the other hand, since people who live close together may resemble each other more in the replies they give to the questions than those who live further apart, the reduction in costs may be offset by an increase in variance. Thus, in comparing several types of clustering, both cost and variance factors need to be taken into account.

We have investigated two different types of clustering suitable for samples drawn from the Electoral Register, by *polling districts* and by *streets*, and we have compared the results obtained from these types of clustering with those given by scattering the interviews systematically over the entire area sampled. The methods used for selecting the samples are discussed in section 2.2.

1.4. *Differences between interviewers.* It is widely believed that the differences in the results obtained by different interviewers working under similar conditions are large, indeed so large that they sometimes have the effect of swamping the errors of random sampling. By arranging the experiment so that direct comparisons were available between pairs of interviewers, we were able to compare the interviewer differences with the sampling errors. This investigation is the subject of section 5.

2. *Design of the Experiment*

2.1. *Location and scale.* After much discussion we decided to carry out the fieldwork in six urban areas, comprising two boroughs of London, two large towns and two small towns, namely:

* It will be convenient to make the terminological distinction between *methods* of dealing with non-response and *types* of clustering.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

London Boroughs	*Large Towns*	*Small Towns*
Hendon (156)	Luton (110)	Kettering (37)
Stoke Newington (49)	Southampton (178)	St. Albans (44)

The figures in brackets are the 1951 census populations in thousands. By taking six areas of different types we hoped to provide a sufficiently broad basis for our conclusions. The areas were chosen within 100 miles of London, for convenience in organizing the fieldwork.

For each area, each of the three organizations, B.M.R.B., M.I.S. and R.S., supplied two full-time* interviewers. In addition, B.I.P.O provided six part-time interviewers in Hendon. There were thus 42 interviewers in all.

Each interviewer was given a list of 30 names and addresses selected from the Electoral Register by one of the methods described in the next section. The number 30 was chosen as being typical of operational conditions. Altogether, for the full-time interviewers there were 180 names for interview in each of the six areas, making 1,080 in all, while for the part-time interviewers there were an extra 180 in Hendon.

2.2. *Types of clustering.* The Electoral Register lends itself readily to the clustering of respondents, since within each area the Register is listed separately for each polling district and within each polling district, at least in urban areas, the individuals are listed by streets. Thus, either polling districts or streets can be used as clusters. Consequently, in each area the following three types of sample were drawn:

Type 1. For each of the two interviewers a systematic† sample of 30 individuals was taken from the Electoral Register for the whole area.

Type 2. For each of the two interviewers two polling districts were selected from the area with probability of selection proportional to number of electors, and 15 individuals were selected systematically from the Electoral Register of each polling district.

The numbers of polling districts in each area, and the average number of electors per district, are given in Table 1.

TABLE 1

Numbers of Polling Districts and Electors

	Number of Polling Districts	*Average Number of Electors per Polling District*
Hendon	34	3,310
Stoke Newington	12	2,944
Luton	45	1,746
Southampton	57	2,179
Kettering	19	1,412
St. Albans	16	2,055

Type 3. Within the polling districts selected for Type 2 in each area, the individuals were arranged into clusters as follows. Any street with 76 or more electors was taken as a cluster. Streets with 75 electors or less were, with the aid of maps, amalgamated with adjacent streets to form clusters of 76–150.

For each of the two interviewers, one cluster was chosen from within each polling district with probability of selection proportional to its number of electors. Where the selected cluster contained 150 electors or fewer, a systematic sample of 15 individuals was chosen from it. Where the cluster contained more than 150 electors, every fifth elector was taken, using a random starting point, until a sample of 15 had been selected.

The minimum cluster size was fixed at 75 to ensure that in a systematic sample of 15 there was a negligible probability of selecting two members of the same household. The combination of

* Full-time here means employed on a full-time basis during the period of the fieldwork, and not necessarily that the interviewers were members of the permanent staffs of the organizations concerned.

† "Systematic" here means "quasi-random," i.e. the sample is selected at regular intervals from a list which is presumed to be randomly arranged.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

small streets into clusters was a tedious job since the streets are listed in the register in alphabetical and not in geographical order, and maps therefore had to be used. In all, out of 630 streets in the 28 polling districts selected from the six areas, 267 had less than 75 electors.

It may be noted that for each of the three methods every elector on the Register of a particular area had the same chance of inclusion in the sample.

2.3. *Allocation of interviewer assignments.* Within each area we had three types of clustering to compare and only two interviewers per organization, leaving aside for the moment the B.I.P.O. interviewers who were treated separately. Consequently, it was impossible to achieve complete balance of areas, types and organizations. In the event we decided to allocate the two interviewers from each organization working in the same area to the same clustering type, which enabled us to make comparisons between interviewers free from organizational differences. Partial balance was achieved by arranging for each organization to use each method in two out of the six areas. The layout adopted is shown in Table 2; the numbers in the table refer to types of clustering.

TABLE 2

Areas, Organizations and Types of Clustering

	B.R.M.B.	*M.I.S.*	*R.S.*	*B.I.P.O.*
Hendon	1	2	3	1, 2, 3
Stoke Newington	2	3	1	
Luton	1	2	3	
Southampton	3	1	2	
Kettering	3	1	2	
St. Albans	2	3	1	

It will be seen that B.I.P.O. lies outside the main experimental design: unlike the other organizations, its interviewers work largely in the evenings and at week-ends, and to make meaningful comparisons it would have been necessary to include within the experiment other organizations working under similar conditions. This was not possible, and as it was felt that the differences between day and evening interviewing were likely to overwhelm some of the comparisons of interest, it was finally agreed that B.I.P.O. would carry out a complete repetition of the experiment, using two interviewers on each of the three types of clustering, in Hendon only.

It should be noted that this allocation to the different types of clustering bears no relation to the non-response part of the experiment; the comparisons of the different methods of dealing with non-response are based on all calls made, whatever the types of clustering used.

2.4. *Questionnaire and record sheet.* We set out to design a questionnaire on which the replies to some of the questions should be correlated with the probability of the informant's being found at home at the time of call. A suitable starting point was provided by the questionnaire on leisure used in the Division's previous experiment (Moser & Stuart, 1953).

The questionnaire we used is reproduced in Appendix A. It is a fairly straightforward one, calling for no special measures on the interviewer's part. It might be expected that respondents would be reluctant to answer the last question, concerned with the frequency with which they were at home, but in the event no special difficulties were encountered.

It was necessary for a detailed record to be kept of the successive calls made and of their results, and the record sheet used for this purpose is reproduced in Appendix B. On the reverse of the sheet further spaces were provided for up to 10 calls.

A special feature of the record sheet is the provision made in columns 4 to 6 for the recording of classificatory information in respect of informants not available at the first call. The use of this information for obtaining a replacement quota sample is discussed in section 2.7.

2.5. *Fieldwork.* The fieldwork was carried out in October and November, 1953. Interviewers were instructed to work in their normal way, except that no limit was placed on the number of recalls, which were to be continued until either an interview was obtained or it was established

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

that none would be obtained by further recalling. Two further special features are discussed in sections 2.6 and 2.7. It should be emphasized that unlimited recalls were made on all individuals selected. The comparisons of the different methods of dealing with non-response were made at the analysis stage.

All interviewers were instructed to work independently, and no overlapping of assignments was allowed.

2.6. *Substitutes for removals.* Since the Electoral Register may be as much as 16 months out of date at the end of its life, an appreciable proportion of the population may have removed from the addresses given in the Register by the time the fieldwork is carried out. The obvious procedure for making good the losses would be to trace the informants to their new addresses where possible. Gray and others (1950) have suggested a method of compensating for any biases involved without doing this.

As a subsidiary part of our experiment, we thought it worth while to investigate a third procedure. Wherever the original informant and his household had been replaced by a new household, interviewers were instructed to replace the removed informant by an adult of the same sex from the new household. Where more than one was available, the oldest or the youngest of them was to be taken, according to whether "O" or "Y"—which appear alternately—was given in column 11 of the record sheet. This means that in substitute households and which contained more than two electors of the same sex, electors who are not the oldest or the youngest are not represented in the sample; however, these constitute an insignificant fraction of the population.

Since the two households may contain different numbers of adults this method does not ensure that all adults have equal probabilities of selection. It seems, however, to provide a useful method of partial compensation since the effect of these variations of probability should be negligible.

2.7. *Replacement by quota sample.* As mentioned in 1.2, one of the methods of dealing with non-response we investigated was the substitution of those not obtained at first call by a quota sample. With this purpose in view, interviewers were instructed that where an informant was not available at first call, but recalls were to be made, they should obtain from other members of the household or neighbours whatever information they could about the age-group and social/income grade of the informant, and code the information in columns 5 and 6 of the record sheet. Since sex was known in advance from the Christian names given in the Register, this provided a basis for constructing a quota sample of substitutes, using these three factors as controls.

Interviewers were instructed to use the social/income grade assessments in normal use by their organizations for quota samples; the differences between organizations here are not substantial (Moser, 1952).

Wherever complete information was not obtainable by the interviewer, quota assignments were set in accordance with the national quota sample structure used by one of the organizations.

In each area, the quota sample fieldwork was carried out by a single interviewer after the random sample fieldwork was complete. The quota sample interviewers, who were provided by M.I.S. and R.S., had not worked on the random sample.

We should make it clear that our aim in investigating this method was to try out a compromise between random sampling and quota sampling. The substitution of a quota sample for those obtainable by recalling cannot be expected to lead to an improvement in accuracy, but it costs a good deal less than recalling, and we thought that if the method were found to work reasonably well, it might lead to the use of partially random methods where full-scale random sampling has already been ruled out for one reason or another.

3. *Results on Non-Response*

The main purpose of this part of the paper is to compare the results given by the different methods of dealing with non-response; these are given in section 3.2. First, however, in section 3.1, we discuss the overall response rates.

3.1. *Response rates.* The results of the attempted interviews may be classified into six categories:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(*a*) Interview obtained;
(*b*) Interview refused or partially refused;
(*c*) Informant removed (substitute taken);
(*d*) Informant removed (no substitute taken);
(*e*) Informant absent from home for long period;
(*f*) Other causes of failure (death, illness, no such address, unsuitable for interview).

Table 3 gives the results of the random sample interviews by Areas, Organizations and Types of clustering.

TABLE 3

Results of Attempted Interviews

	Results (per cent.)						*Total Number of Attempted Interviews*
	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	
(a) *By Areas**							
Hendon	68·3	8·3	2·8	5·6	7·8	7·2	180
Stoke Newington	64·4	7·2	8·3	6·1	5·6	8·3	180
Southampton	68·9	5·6	6·1	5·0	7·8	6·7	180
Luton	75·6	5·6	5·0	6·1	4·4	3·3	180
St. Albans	72·2	8·3	3·9	3·9	3·9	7·8	180
Kettering	69·4	8·9	4·4	4·4	6·1	6·7	180
(b) *By Organizations*							
B.M.R.B.	69·7	7·2	5·8	5·6	4·7	6·9	360
M.I.S.	66·9	9·4	5·0	5·6	5·6	7·5	360
R.S.	72·8	5·3	4·4	4·4	7·5	5·6	360
B.I.P.O.†	75·6	6·1	2·2	7·8	4·4	3·9	180
(c) *By Types of clustering*							
Type 1	70·6	6·7	3·9	5·6	6·9	6·4	360
Type 2	72·8	6·7	6·4	4·4	3·3	6·4	360
Type 3	66·1	8·1	5·0	5·6	7·5	7·2	360
Total (original informants)	70·6	7·1	4·7	5·6	5·7	6·3	1,260
Total (including substitutes)	74·4	7·6	—	5·6	6·0	6·3	1,260
Total (excluding (*f*))	79·5	8·1	—	5·9	6·4	—	1,180

* Excluding the interviews carried out by B.I.P.O. in Hendon.
† In Hendon only.

The penultimate row of Table 3 was calculated by taking account of the results of the 4·7 per cent. of cases under (*c*) for which substitutes were taken. The percentages in the last row were calculated after the exclusion of the 80 cases under (*f*). This was done on the ground that category (*f*) consists of individuals who either should not have appeared on the sampling frame, or who could not have been interviewed as a result of any sampling method.

We cannot think of any cogent reason for the high refusal rate. A previous survey (Moser and Stuart, 1953) of much the same size on the same subject, carried out by the same organizations, had a refusal rate of only 3·3 per cent. However, 22 of the 82 refusals occurred after the third call out of 165 cases outstanding. This gives a refusal rate of 13·3 per cent. at the fourth and successive calls against 5·5 per cent. for the cases completed by the end of the third call. A possible explanation would be that the unfamiliar instruction to continue recalling indefinitely led some interviewers to enter "refusals" at later calls to save them from making further calls. However, this explanation does not account for the high refusal rate at the first three calls. Whatever the cause of this, there is some suggestion in the data that refusal rates based on three calls only (such as the 3·3 per cent. quoted above) may be underestimates; in the present case, later calls produced a rise in the overall refusal rate from 5·5 per cent. to 7·1 per cent.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The fact that Stoke Newington among areas, M.I.S. among organizations, and Type 3 among clustering types all have low success rates is partly attributable to a difficulty which arose in the field. The Stoke Newington Type 3 samples, which were carried out by M.I.S. interviewers, fell partly in new blocks of Council flats, some of which were old people's flats, and many of the sample members were difficult to contact and to interview.

The proximity of sample members in Type 3 samples generally may have resulted in advance information of the interviewer's presence becoming available to unwilling informants, with a consequent increase in the difficulties of obtaining interviews.

The high rate of removals, 10·3 per cent. of the original sample, can at least in part be attributed to the fact that, when the fieldwork was carried out, the current Electoral Register had been completed a year earlier. It will be seen that about 45 per cent. of all removals were replaced by substitutes under the procedure discussed in section 2.6; there were 59 substitutions, of which 81 per cent. resulted in successful interviews and 10 per cent. in refusals. The ratio of refusals to successes was therefore 1 in 8, as against approximately 1 in 10 for the original samples, but the difference is not important. It seems from the evidence of this experiment that there is no practical difficulty in using this method of substitution for removals, and although it afforded only a partial solution of the problem, it resulted in the inclusion in the final sample of substitutes for about 4 per cent. of the originally attempted interviews.

It will be seen from Table 3 that, including substitutes, the overall success rate was raised to 74·4 per cent. and that the elimination of category (*f*) brings the rate up to almost 80 per cent. Even so, the success rate seems rather low, especially bearing in mind that unlimited recalls were required. However, it must be remembered that the working conditions for the interviewers were to some extent unusual. Not only were unlimited recalls required—itself an unusual feature which may have had a somewhat demoralizing effect on them—but they had to collect the age and social/income grade data for those not at home, and also to work the substitution procedure for removals. These may have combined to give the interviewers the feeling that they were working on a rather difficult job, which may have had the effect of depressing the success rate.

The figure of 80 per cent. refers only to those on the Electoral Register who might have been interviewed; if allowance is made for the deficiencies of the Register, this figure would, of course, be reduced.

3.2. *Comparisons of different methods of dealing with non-response.* As has been mentioned, the different types of clustering were ignored for the purpose of analysing the effects of different methods of dealing with non-response. The data for the analysis therefore consist of the overall random sample, classified according to the number of the call at which the interview was obtained, and the quota sample of replacements for those not obtained at first call.

The results were tabulated for all interviews obtained at the first call, for interviews obtained in up to 3 calls and for the entire sample. The one-call sample shows the full extent of the bias which can arise from insufficient calling back while the three-call sample is a standard procedure. As previously explained, the all-calls sample serves as our standard. These three types of sample will be referred to as R_1, R_3 and R_T respectively.

The interviews at the first call also provide the estimates based on re-weighting by at-home probabilities. For this purpose, the interviews at first call were classified according to the number of occasions (including the time of call) on which the respondent stated that he was at home in answer to question 31. It will be noted from the questionnaire that the question was asked about the *six* preceding days, as against the five used by Politz and Simmons, so that there were seven occasions in all. The Politz-Simmons (P.S.) estimates were then constructed by weighting each reply according to the reciprocal of the number of occasions. Of the 374 interviews at first call, only 19, or 5 per cent., did not provide full information on times at home and of these only 2 flatly refused to give any information.

We should emphasize that the Politz-Simmons method is normally suggested for evening interviewing and it might also be expected to work reasonably well for daytime interviewing of housewives. Since there is little chance of finding an employed person at home during normal working hours, the method cannot be expected to work well when first calls on a sample of individuals are made during the day, as most of ours were except for the B.I.P.O. interviews. How-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ever, since it added virtually nothing to the cost of the fieldwork, we thought the procedure worth trying. Although we cannot claim to have given the method a fair trial we hoped that our experience might throw some light on its practicability and that we should obtain some indication of the extent to which it corrects for the bias of the R_1 sample.

Finally, the matched quota sample of replacements was used to construct a composite sample, which we shall call Q_1, consisting of the random sample respondents interviewed at first call together with the quota replacements of all those on whom a second call was to be made. In the same way, a second composite sample, Q_2, was formed consisting of all random sample respondents obtained at the first two calls together with the quota replacements after the elimination of those replacing respondents interviewed at the second call. Similarly, a composite sample Q_3 was constructed, containing the random sample respondents at the first three calls and the quota sample residual. These three samples, Q_1, Q_2 and Q_3, may be taken to represent what the results would have been if random sampling had been abandoned for quota sampling after the call in question. It should be noted, however, that whereas Q_1 is an operational sample, Q_2 and Q_3 are not, in that as further calls are made, more information becomes available on which the quota sample of replacements could be based. This additional information was not requested of the interviewers, the aim being to reduce the complexity of the fieldwork.

We thus have, in all, seven values for each question analysed and these are presented in Table 4. For the question and attribute indicated in the first column, the percentage given by each method is shown. Below these appear, in italics, the standard errors now to be described, and below these again, in parentheses, the sample sizes on which they are based. The standard errors in the R_1, R_3 and P.S. columns relate to the *differences* between those columns and the R_T column. The standard error in the R_T column relates directly to the result above it.

TABLE 4

Results for Different Methods of Dealing with Non-response

Question and Attribute Analysed (per cent.)	*Random Sample Results*				*Quota Replacement of Non-response at*		
	At First Call R_1	*At 3 Calls* R_3	*At All Calls* R_T	*By Politz-Simmons (P.S.)*	*One Call* Q_1	*2 Calls* Q_2	*3 Calls* Q_3
2*a*. Women who are housewives	92·6*	89·3	89·1	91·2	86·6	88·3	88·3
	1·36	*0·49*	*1·40*	*1·30*			
	(258)	(450)	(505)	(247)	(580)	(580)	(581)
3. Of those with jobs who work full-time	79·4†	88·0	88·1	84·3*	88·9	89·4	88·9
	2·37	*0·60*	*1·40*	*1·38*			
	(141)	(483)	(578)	(136)	(606)	(630)	(642)
4. Workers employed in manufacturing trades	22·9*	30·3	31·3	21·4†	22·2	26·6	28·3
	3·41	*0·85*	*2·15*	*1·68*			
	(140)	(482)	(576)	(135)	(600)	(627)	(640)
5. Of full-time workers who work days	71·4*	79·8	81·1	74·3†	80·8	81·2	80·7
	3·27	*0·77*	*1·86*	*1·91*			
	(112)	(425)	(508)	(108)	(536)	(563)	(571)
6. Workers whose time to work is less than 20 mins.	54·0	54·0	52·3	50·7	61·0	58·1	55·4
	3·67	*0·96*	*2·04*	*2·20*			
	(139)	(462)	(557)	(134)	(561)	(592)	(605)
7. Who went to pictures in last 7 days	28·7	29·3	30·3	27·2*	32·4	30·7	29·7
	1·85	*0·56*	*1·51*	*1·14*			
	(373)	(822)	(937)	(354)	(1,074)	(1,078)	(1,081)
8. Who own a television set	30·8	32·1	32·6	33·4	30·3	30·6	30·8
	1·88	*0·51*	1·57	*1·52*			
	(374)	(823)	(937)	(355)	(1,074)	(1,079)	(1,082)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Question and Attribute Analysed (per cent.)	*Random Sample Results*				*Quota Replacement of Non-response at*		
	At First Call R_1	*At 3 Calls* R_3	*At All Calls* R_T	*By Politz-Simmons (P.S.)*	*One Call* Q_1	*2 Calls* Q_2	*3 Calls* Q_3
8*b*. Who have not watched television in last seven days	63·8 *2·05* (337)	62·7 *0·64* (732)	61·9 *1·61* (839)	59·2 *1·68* (322)	62·3	62·6	63·2 (1,065)
9*a*. Who bet on football pools	36·1† *1·99* (374)	41·8* *0·61* (823)	43·5 *1·82* (938)	35·7† *1·42* (355)	43·4 (1,075)	43·5 (1,079)	44·2 (1,082)
10*a*. Who smoke	50·5* *1·98* (374)	57·0 *0·60* (823)	57·7 *1·64* (938)	55·9 *1·43* (355)	54·8 (1,074)	55·9 (1,079)	56·5 (1,082)
10*b*. Of men smokers who smoke cigarettes	73·3 *4·00* (86)	73·2* *0·97* (284)	75·2 *3·13* (331)	77·9 *2·11* (82)	77·3 (366)	74·9 (370)	74·1 (371)
10*c*. Of all cigarette smokers who smoke 8 or more cigarettes a day	54·8* *2·95* (175)	61·2 *0·88* (423)	62·2 *2·06* (492)	60·5 *2·14* (168)	63·4 (526)	62·1 (534)	61·0 (546)
11. Of those reading a daily paper who read *Daily Mirror*	40·5 *2·15* (316)	39·4 *0·64* (710)	39·6 *1·84* (809)	40·9 *1·61* (297)	39·1 (919)	39·8 (940)	39·5 (932)
12. Of those reading a Sunday newspaper who read *News of World*	51·1 *2·16* (325)	51·4 *0·68* (716)	52·1 *2·14* (824)	54·1 *1·63* (308)	48·1 (931)	50·0 (938)	49·3 (938)
13*a*. Who read periodicals regularly	51·9 *2·00* (374)	53·6 *0·61* (823)	53·0 *1·97* (938)	54·8 *1·47* (355)	51·6 (1,074)	51·3 (1,079)	51·5 (1,082)
13*b*. Of those reading periodicals who read picture and general entertainment types	25·5 *2·54* (192)	27·8 *0·72* (439)	28·3 *1·88* (494)	28·1 *2·20* (185)	25·9 (552)	27·5 (552)	27·7 (556)
15. Who are reading a book now	23·5 *1·78* (374)	27·6 *0·54* (822)	26·9 *1·77* (937)	28·1 *1·57* (355)	28·9 (1,072)	28·8 (1,077)	29·7 (1,080)
16. Who hold a ticket in public library	30·5 *1·86* (374)	31·8 *0·57* (822)	31·2 *1·58* (937)	28·7* *1·25* (355)	35·0 (1,070)	34·5 (1,075)	34·1 (1,078)
17*a*. Who had at least one holiday away from home last year	54·2† *1·96* (374)	59·8 *0·60* (823)	60·5 *1·88* (937)	58·5 *1·43* (355)	59·3 (1,074)	58·9 (1,078)	60·1 (1,082)
17*b*. Of those having holiday whose holiday was longer than 13 days	50·2 *2·81* (203)	53·5 *0·83* (491)	53·7 *2·29* (567)	55·4 *1·93* (191)	54·8 (633)	55·2 (635)	54·5 (651)
18. Who own a bicycle only	18·2† *1·76* (374)	26·7 *0·53* (823)	25·9 *1·48* (938)	22·0* *1·44* (355)	23·4 (1,075)	24·7 (1,079)	25·5 (1,082)
19*a*. Who own (or whose family own) a car	23·3 *1·71* (374)	24·2 *0·52* (823)	24·0 *2·28* (938)	24·4 *1·37* (355)	21·5 (1,075)	21·7 (1,079)	22·3 (1,082)
20*a*. Who do any gardening	58·5* *1·93* (374)	63·8 *0·59* (823)	63·4 *1·85* (938)	61·3 *1·36* (355)	56·6 (1,074)	60·7 (1,078)	60·7 (1,081)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Question and Attribute Analysed (per cent.)	*Random Sample Results*				*Quota Replacement o, Non-response at*		
	At First Call R_1	*At 3 Calls* R_3	*At All Calls* R_T	*By Politz-Simmons (P.S.)*	*One Call* Q_1	*2 Calls* Q_2	*3 Calls* Q_3
21*a*. Who ever have a drink of beer, wine or spirits	73·5	76·4	76·6	74·0	69·5	73·0	73·8
	1·70	*0·52*	*1·59*	*1·22*			
	(374)	(823)	(938)	(355)	(1,075)	(1,079)	(1,082)
22*a*. Who have a sport activity . .	20·9†	26·8*	28·2	24·2*	31·2	28·5	28·4
	1·81	*0·55*	*1·84*	*1·40*			
	(374)	(823)	(938)	(355)	(1,075)	(1,079)	(1,082)
23. Who are married . . .	79·1	75·9	76·1	77·3	73·1	73·9	73·5
	1·71	*0·52*	*1·26*	*1·38*			
	(374)	(823)	(938)	(355)	(1,075)	(1,079)	(1,082)
25. Who live in a house built or rebuilt since 1945	14·5	15·0*	16·0	13·4*	14·3	13·7	14·5
	1·51	*0·45*	*2·27*	*1·06*			
	(359)	(801)	(908)	(342)	(949)	(1,006)	(1,021)
26. Who live in household with five or less rooms	70·2	67·8	68·0	71·2*	69·9	69·6	68·8
	1·90	*0·58*	*1·87*	*1·44*			
	(366)	(809)	(923)	(352)	(981)	(1,020)	(1,034)
27. Who are men	31·0†	45·2	46·1	39·2†	46·5	46·2	46·3
	2·00	*0·61*	*1·75*	*1·61*			
	(374)	(823)	(938)	(355)	(1,072)	(1,077)	(1,080)
28. Of respondents whose age is 20–29 years	13·5	14·7	14·5	18·0*	17·2	16·0	15·4
	1·42	*0·43*	*1·30*	*1·26*			
	(371)	(819)	(934)	(352)	(1,059)	(1,071)	(1,074)
29. Of respondents who finished education at 14 years or less	68·3	66·7	67·1	63·8*	60·0	62·8	63·7
	1·90	*0·58*	*2·06*	*1·49*			
	(369)	(817)	(931)	(351)	(1,062)	(1,074)	(1,076)
30. Of men whose income was less than £7 10*s*. p.w. (of males only)	44·1*	33·1	33·1	37·3	39·9	35·9	35·4
	3·83	*0·94*	*2·83*	*2·54*			
	(111)	(356)	(414)	(106)	(459)	(474)	(477)

* Indicates a difference significant at the 5 per cent. level.
† Indicates a difference significant at the 1 per cent. level.

Standard Error Calculations and Hypotheses Tested

(1) R_T percentages. An estimate of sampling variance was made separately for each interviewer used in the enquiry. For interviewers employed on clustering Type 1, this was done directly from the standard formula $\frac{p(1-p)}{n-1}$. For interviewers employed on Types 2 and 3, each interviewer's assignment consisted of two clusters, and the sampling variance was estimated from the differences between the cluster proportions, i.e., $\frac{1}{4}(p_1 - p_2)^2$.* To obtain the sampling variance of the R_T percentage, these individual variances were combined by weighting them by the squares of the sample numbers on which they were based and dividing the weighted sum by the square of the total sample number. The variance thus obtained takes account only of sampling within areas. In a normal survey, there would be an additional component of variance due to the selection of areas at the first stage. However, in our case the six areas, purposively chosen, form our domain of study, and there is no first-stage component of variance.

These variances have been calculated taking sample numbers as fixed, whereas in fact they are random variables owing to variations in response rates. However, the variances remain valid if the cluster proportions are uncorrelated with the numbers on which they are based, as seems likely.

* This is a slight overestimate which is strictly applicable only to sampling with replacement, whereas our samples were selected without replacement.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The standard errors given in the R_T column of Table 4 are not used in the interpretation of the differences between the results of the other methods and the R_T results; they are printed for information only.

(2) In order to test the difference between the results given by R_1 and R_T we must be clear about the precise form of the hypothesis under consideration. The replies to a given question can be classified in two ways: firstly, according to whether or not the respondent possesses the attribute in question, and secondly according to whether or not the reply was obtained at the first call. We wish to test the hypothesis that these two classifications are statistically independent.

This is equivalent to testing whether the replies in R_1 constitute a random sub-sample of the replies in R_T. Thus we may use the ordinary theory of sampling from a finite population to calculate the standard error of the difference between percentages in R_1 and R_T. The formula is therefore

$$S.E.\ (P_1 - P_T) = \sqrt{\frac{P_T(100 - P_T)}{n_1}\,\frac{n_T - n_1}{n_T - 1}}$$

where P_1, P_T are the percentages in R_1 and R_T and n_1, n_T are the corresponding sample sizes. A similar formula holds for the standard error of the difference between the percentages in R_3 and R_T. These standard errors may be used to carry out significance tests in the ordinary way.

(3) In the Politz-Simmons method, let i denote the number of occasions, including the time of call, on which the respondent declares himself to be at home. The absence of bias in the estimates given by the method depends firstly on the condition that $i/7$ correctly estimates the probability that the person is at home and secondly on the condition that the fraction of the population which would never be interviewed at first call is negligible. It is the infringement of this latter condition which is more likely to bias the results when first calls are made during the day-time. This effect is most easily seen by applying the check proposed by Politz and Simmons. If the weights used in the method are accurate, their sum should be approximately equal to the total number of interviews obtained. We find a sum of 554, against an achieved total of 938 interviews, which clearly reflects the large proportion of the population never at home at the times the first calls were made.

When both conditions are satisfied the P.S. values are unbiased estimates of the R_T values and the estimated standard error of the difference between the two values is given by

$$S.E. = \frac{1}{n_T}\sqrt{\left\{\sum_{i,j}\frac{7}{i}\left(\frac{7}{i} - 1\right)(x_{ij} - x)^2\right\}}$$

where x_{ij} is 1 or 0 according to whether the attribute under consideration is or is not possessed by the ij^{th} individual and x is the P.S. value itself (Durbin, 1953). This standard error may be used in the ordinary way to test the hypothesis that the P.S. values are unbiased.

On the assumption that the validity conditions for the P.S. method are fulfilled, the overall sampling variance of the P.S. estimate is the sum of two components, the first being the square of the S.E. calculated as in the previous paragraph, and the second being the variance of the R_T estimate, calculated as described under (1).

(4) There is no method of computing a standard error for the Q_1, Q_2 and Q_3 samples. It should be noted that the sample number for Q_1 always exceeds that for R_T, since some respondents for whom quota replacements were made were not interviewed at calls subsequent to the first. The variation in sample numbers between Q_1, Q_2 and Q_3 is due to the varying applicability of questions to different respondents and to occasional failure to answer a particular question.

3.3. *Discussion of the results.* Although Table 4 is rather complicated, the picture it presents is not difficult to interpret. Considering the random samples first, it will be seen that despite the small standard errors for the R_3 results, their deviation from the R_T results are rarely significant, as the following short summary indicates:

	Samples		
	R_1	R_3	*P.S.*
Number of differences significant at: 5 per cent. level . .	6	4	9
,, ,, ,, : 1 per cent. level . .	7	–	4

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The R_3 sample has four significant differences out of 32, as against less than two to be expected theoretically, but the excess would not be significant in a sample of 32 even if the different questions were independent, and they are not.

On the other hand, the results for the R_1 and P.S. samples establish beyond reasonable doubt that they must be regarded as biased. The hypothesis that the R_1 sample constitutes a random sub-sample of the R_T sample is, as a whole, decisively rejected. Similarly, it is clearly established that the conditions for the applicability of the P.S. method are not fulfilled. Thus, as we expected, the method cannot be regarded as satisfactory for daytime surveys of individuals.

In contrast, the performance of the R_3 sample is satisfactory, and confirms that the common practice of confining random samples to three calls results in little, if any, bias when compared with the method of unlimited recalls. However, it should be remembered that this conclusion leaves out of consideration any biases, due to the non-responding 20–25 per cent. of the original population, which are common to both the R_3 and R_T samples.

Close examination of Table 4 reveals that, as might have been expected, the questions which give rise to significant differences between the random sample results are those for which an important factor in determining replies is whether or not the informant has a paid job. Separate tables for men and women reinforced this view, but threw no fresh light on the matter. This effect is directly obvious in Table 4, where the percentage of employed persons with full-time jobs, the percentage of workers in the manufacturing trades and the percentage of day workers among full-time workers are all seen to be badly biased downwards in both the R_1 and P.S. samples (questions 3, 4 and 5). Other effects are the downward income bias and the over-representation of housewives (q. 30 and 2*a*). Downward biases in the percentages betting on football pools, owning a bicycle and having a sport activity are also, somewhat less directly, attributable to this factor (q. 9*a*, 18 and 22*a*). The tendency of the first call to pick up the less active part of the sample is demonstrated in the questions on cinema-going, the reading of picture and general entertainment type magazines, on holiday-making and on gardening (q. 7, 13*b*, 17*a* and *b*, and 20*a*). There is also a slight under-statement of television ownership and watching (q. 8*a* and 8*b*). The strong over-representation of women in the first-call sample (q. 27) has as a consequence a low percentage of smokers (q. 10*a*), as well as contributing to the other biases discussed above.

It will be seen that in most cases the discrepancies referred to have been corrected by the time the third call has been reached.

Turning now to the quota replacement samples, it might have been expected that the influence of the quota replacements in the Q_1 sample would be to close the gap between the R_1 and the R_T results. Sometimes this has occurred, notably in the questions on full-time employment (q. 3) on day-working (q. 5), on football pools (q. 9*a*), on smoking (q. 10*a* and 10*c*), on holidays (q. 17*a* and 17*b*), bicycle-ownership (q. 18), sport (q. 22*a*) and income of men (q. 30). However, this tendency is by no means uniform, and distinctly worse results than those obtained by the R_1 sample are displayed by the Q_1 sample for the questions on time taken to get to work (q. 6), Sunday newspaper readership (q. 12), public library membership (q. 16), car ownership (q. 19*a*), gardening (q. 20*a*), and drinking (q. 21*a*), while the well-known tendency of quota samples to pick up a rather young and rather highly educated sample are clearly brought out in the answers to questions 28 and 29. All in all, the performance of the Q_1 sample is not consistently good or bad. The Q_2 and Q_3 samples, because of the larger number of respondents they have in common with the R_T sample, naturally produce results much closer to the R_T results.

A simple way of making an overall comparison of the performances of the different methods is as follows. For each question, the differences between the R_T result and each of the other six results are written down and, ignoring sign, these deviations are ranked upwards in order of size, giving average ranks for ties. The total of ranks allotted to each method is then obtained by addition, with the following result:

TABLE 5

Rank Analysis of Table 4

	Method						
	R_1	R_3	*P.S.*	Q_1	Q_2	Q_3	*Total*
Sum of ranks . . .	146	57½	134½	143½	103	87½	672

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Crude as this analysis is, it brings out clearly the disparities and, just as important, the similarities in the overall performances of the methods. As is reasonable in view of the nature of the differences we are ranking, R_3 stands out as the best method, and the quota methods follow in the expected order. Most interesting, however, is the fact that there is practically nothing to choose in the rank sums of the R_1 and Q_1 methods, with the P.S. rank sum slightly better than these. The actual differences between the rank sums, of course, have no direct interpretation for our purpose.

Thus the impressions obtained from the detailed examination of Table 4 are, on the whole, confirmed by the rank analysis. The latter conceals the fact that the mean absolute deviation of the Q_1 results from the R_T results is 3·0 per cent., against 3·3 per cent. for the P.S. deviation, indicating a slightly more erratic tendency in the P.S. method. This apart, there seems to be no particular reason to prefer the Q_1 sample. Since, as we have already seen, the P.S. method produces rather poor results, we conclude that the Q_1 sample has hardly justified itself. The Q_2 and Q_3 samples are, of course, increasingly correlated with the R_T sample, so that their improvement over Q_1 is hardly surprising, but it is clear from the rank sum analysis and Table 4 that even Q_2 and Q_3 do not compare with the R_T results as well as the R_3 sample does.

4. *Results on Clustering*

4.1. *Rate of interviewing.* There are various ways in which the relative success of the three types of clustering may be investigated, of which the simplest is to compare the achievement rates for the three types day by day. This can be done by combining the results for each interviewer's first day's work, second day's work, and so on. In a few cases the interviewer did not begin his assignment with a full day's work and for this reason, if the first day's interviewing consisted of three or fewer calls, we have ignored it and have regarded the following day as the first day's work. Only three interviews were excluded on this account. All later days were included regardless of the number of calls made. The results are given in Table 6. For obvious reasons the B.I.P.O. part-time interviewers are excluded.

TABLE 6

Numbers of Interviews Achieved on Successive Days

	Day												
	1	2	3	4	5	6	7	8	9	10	11	12	*Total*
Type 1 . .	48	57	52	48	27	12	9	8	5	0	1	1	268
Type 2 . .	71	88	53	48	16	6	2	1					285
Type 3 . .	48	59	68	36	18	9	7	8					253

It should be remembered that the later entries are based on fewer interviewers as some of them had already completed their assignments.

It is clear from this table that not only did Type 2 clustering result in a greater number of interviews than Types 1 and 3, but these interviews were obtained more rapidly. The difference between Types 1 and 3 is not great, though the interviewing finished earlier in Type 3 than in Type 1.

Although it was to be expected that Type 2, in which the informants are clustered in polling districts, would prove more convenient for the interviewers than Type 1, in which the informants are scattered over the entire area, it is rather surprising that Type 3, in which the informants are very close together, does not prove more convenient still. One possible explanation has been given in section 3.1, namely that the closer proximity of the informants in Type 3 may have led to some of them being warned in advance of the investigator's presence in the neighbourhood. A second possibility is that the investigators rapidly became tired of walking up and down in a small neighbourhood trying to find the informants at home. They were able to make larger numbers of calls, but because the calls were made soon after one another the probability of success was not so great as when the calls are spread out over the day and evening.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In this connection it is worth giving the average numbers of calls per interviewer's assignment of 30 attempted interviews. These were:

Type 1, 56·8
Type 2, 60·6
Type 3, 75·9

There is little difference between the values for Types 1 and 2 but the average for Type 3 is over 25 per cent. higher than these.

4.2. *Average costs of interviews for the three types of clustering.* Although a general impression of the results given by the three types of clustering can be obtained from Table 6, for more precise comparisons we need estimates of the average cost of interviews achieved at the different calls for each of the three types of clustering. These can be obtained by the following least-squares method, using the same data as were considered in the last section.

Taking the interviewer-day as the unit of cost, let a_i be the average cost of a successful i^{th} call, and n_{ij} the number of interviews at the ith call obtained on the jth interviewer day. We choose as our estimates of $a_1, a_2, \ldots$ those values which minimize the sum of squares

$$\Sigma (1 - n_{1j}a_1 \quad \ldots \quad n_{6j}a_6)^2,$$

where the summation is taken over all interviewer/days of the type of clustering concerned, and the suffix 6 denotes all calls after the fifth. The results obtained in the different towns were amalgamated and local travel costs were ignored, since these are so small in relation to wage costs that the effect of variations in them on the costs of the different types of clustering must have been negligible. Standard errors were calculated by the ordinary methods of multiple regression analysis on the assumption that the residuals $(1 - n_{ij}a_1 \quad \ldots - n_{6j}a_6)$ were independently distributed with zero means and constant variance. The results are given in Tables 7–9.

TABLE 7

Average Cost of Interviews on Clustering Type 1

Call i	*Number of Interviews at* i^{th} *Call* n_i	*Number of Interviews in Calls up to* i^{th} $\sum_1^i n_r$	*Average Cost of a Successful* i^{th} *Call* a_i	*Average Cost of Interviews Obtained from Calls up to* i^{th} $\sum_1^i n_r a_r / \sum_1^i n_r$	*Standard Error of Estimate* a_i $s(a_i)$
1	109	109	0·187	0·187	0·035
2	108	217	0·199	0·193	0·036
3	30	247	0·304	0·206	0·097
4	14	261	0·268	0·210	0·128
5	3	264	0·753	0·216	0·339
>5	4	268	0·541	0·221	0·240

TABLE 8

Average Cost of Interviews on Clustering Type 2

i	n_i	$\sum_1^i n_r$	a_i	$\sum_1^i n_r a_r / \sum_1^i n_r$	$s(a_i)$
1	118	118	0·114	0·114	0·030
2	99	217	0·156	0·133	0·042
3	33	250	0·125	0·132	0·071
4	21	271	0·241	0·141	0·102
5	4	275	0·582	0·147	0·308
>5	10	285	0·334	0·153	0·144

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 9

Average Cost of Interviews on Clustering Type 3

i	n_i	$\sum_1^i n_r$	a_i	$\sum_1^i n_r a_r / \sum_1^i n_r$	$s(a_i)$	a_i (*Excluding Stoke Newington*)
1	83	83	0·165	0·165	0·039	0·154
2	76	159	0·151	0·158	0·050	0·152
3	42	201	0·184	0·164	0·068	0·199
4	24	225	0·178	0·165	0·099	0·166
5	19	244	0·291	0·175	0·123	0·212
>5	9	253	0·258	0·178	0·107	0·346

For both Types 1 and 2 the average cost per interview increases steadily with number of call but for Type 3 it remains fairly constant until the fifth call. However, the increase is not very great considering that it buys a certain amount of security against the risk of non-response bias.

In general the results support the conclusions of the previous section. Thus Type 2 turns out to be superior to Types 1 and 3. However the average cost of interviews in Type 3 clusters is less than that for Type 1 interviews by an amount which is greater than one would have supposed from the evidence of Table 6.

As was mentioned in section 3.1, the low overall response rate achieved in Type 3 interviews was partly due to the difficulties encountered by the two M.I.S. investigators working on this type of clustering in Stoke Newington. Although such difficulties are to be expected from time to time in random sample surveys, it was thought worth while to recalculate the average costs with Stoke Newington excluded. The results for Type 3 are given in the final column of Table 9; those for Types 1 and 2 differed so little from the original values that they have not been given. Although the average cost per interview on Type 3 has been reduced by the exclusion of Stoke Newington, the improvement is not great and it still remains higher than for Type 2. We have therefore reinforced the rather surprising conclusion that, so far as this particular survey is concerned, clustering by streets has not led to any reduction in costs compared with clustering by polling districts. Both types of clustering, however, gave lower costs per interview than systematic scattering over the entire towns.

The standard errors of the estimate a_i are rather large; this is due to the small sample numbers n_i involved, especially after the third call. To calculate the standard errors of the overall averages given at the bottom of the fifth column of Tables 7–9, we must assume that the numbers in the second column are fixed in repeated samples. On this assumption the standard errors are:

	Average Cost	*Standard Error*		*Difference*	*Standard Error*
Type 1	0·221	0·016	Type 1–Type 2	0·068	0·021
Type 2	0·153	0·014	Type 1–Type 3	0·043	0·022
Type 3	0·178	0·015	Type 3–Type 2	0·025	0·020

Thus the difference in average cost between Types 1 and 2 is highly significant, and that between Types 2 and 3 is not significant, while the difference between Types 1 and 3 is on the borderline of significance.

These calculations of standard errors show that the estimates of average costs are subject to fairly large sampling fluctuations and hence that the conclusions we have based on them must be regarded with a certain amount of caution.

Summarizing the results, clustering by polling districts had the effect of reducing interviewing costs by about one-third, but contrary to expectation, the further reduction of the size of clusters has, under the field work conditions in this survey, caused interviewing costs to rise, although they are still less than for interviews dispersed over the whole area.

The results from the three types of clustering have been combined in Table 10 by weighting according to the numbers involved.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 10

Average Cost of an Interview up to a Given Call for All Types of Clustering Combined

Calls	*Average Cost of an Interview in Calls up to this Number*	*Index*
1	0·153	100
2	0·162	106
3	0·167	109
4	0·172	112
5	0·179	117
All	0·183	120

The average cost rises slowly from call to call, and for three calls is less than 10 per cent. higher than for one. For unlimited recalls average cost has risen by 20 per cent. Although the extra cost of interviews obtained by recall is less than is often supposed, the increase is greater than was suggested by the data analysed by Durbin (1953). The difference between the two sets of results may be attributable to variations in fieldwork conditions.

4.3. *Variances of estimates based on the three types of clustering.* The fact that a clustered sample costs less than a scattered sample does not necessarily mean that it is more efficient in terms of information per unit of expenditure. If the replies given by individuals within clusters are positively correlated, the sample mean will have a higher variance when the observations are clustered than when they are dispersed over the entire area. Consequently, in addition to the interviewing costs of the three types of clustering, we must examine their variances.

Let σ_b^2 denote the variance between true cluster means, each cluster being weighted by its probability of selection, and σ_w^2 denote the variance between individuals within clusters. Then the variance of the sample mean, when the sample consists of m clusters of n observations each, is $\frac{\sigma_b^2}{m} + \frac{\sigma_w^2}{mn}$, neglecting the slight correction necessary to allow for the finiteness of the population. When the mn observations are selected at random from the entire population the variance is $\frac{1}{mn}(\sigma_b^2 + \sigma_w^2)$. Thus the ratio of the two variances is $\frac{n\sigma_b^2 + \sigma_w^2}{\sigma_b^2 + \sigma_w^2}$ and the clustered sample must be less accurate than the unclustered sample unless $\sigma_b^2 = 0$.

To estimate σ_b^2 and σ_w^2 for a particular area, let s_1^2 denote an estimate of variance between individuals in the Type 1 sample, and let s_2^2 and s_3^2 denote estimates of variance between individuals in the same cluster in Types 2 and 3 respectively. These estimates were based on the results of the all-calls sample. Then s_1^2 estimates $(\sigma_b^2 + \sigma_w^2)$ and s_2^2 or s_3^2 estimates the corresponding σ_w^2. Thus for the particular area we can test the hypothesis $\sigma_b^2 = 0$ by testing the ratio s_1^2/s_2^2 or s_1^2/s_3^2. For the purpose of carrying out composite tests over all areas, we pooled the estimates of variance obtained separately for each area, and tested the ratio of the pooled estimates by Fisher's z. Since the tests have been based on pooled estimates of variance they are strictly valid only if the true variance between individuals is the same in each area, but they should not be seriously affected by any slight differences which are likely to exist. The results of the tests are indicated by the asterisks in Table 11.

For the estimation of the accuracy ratios

$$\frac{n\sigma_b^2 + \sigma_w^2}{\sigma_b^2 + \sigma_w^2},$$

the assumption of equal variances in the six areas is unnecessary. Taking Type 2 first, we have used as our estimate of σ_w^2 the mean of the estimates s_2^2, calculated separately for each of the six areas, and this is denoted by v_2. In the same way, our estimate of $(\sigma_b^2 + \sigma_w^2)$ is the mean of the six separate values of s_1^2, and this is denoted by v_1. Since the achieved number of interviews differed from cluster to cluster, the average value $\bar{n}_2$ over the 24 clusters was used. Thus our estimate of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$\frac{n\sigma_b^2 + \sigma_w^2}{\sigma_b^2 + \sigma_w^2}$$

for Type 2 is given by

$$r_2 = 1 + \frac{(\bar{n}_2 - 1)(v_1 - v_2)}{v_1}.$$

Similarly the estimate for Type 3 is

$$r_3 = 1 + \frac{(\bar{n}_3 - 1)(v_1 - v_3)}{v_1}.$$

Values of r_2 and r_3 are given for each question analysed in Table 11. It will be noted that σ_b^2 is estimated by the difference between two variances calculated from different samples; this difference was sometimes negative and in such cases we inferred that $\sigma_b^2 = 0$ and hence that the accuracy ratio was unity.‡ These cases are indicated by daggers in Table 11.

The calculations have been based on the results obtained by the full-time interviewers, in order to make them comparable with the cost figures given in the last section, which were calculated on this basis.

TABLE 11

Ratio of Variance of Clustered Sample Estimate to Variance of Scattered Sample Estimate

Question No. and Percentage for which the Ratios were Calculated (per cent.)	*Clustering Type 2*		*Clustering Type 3*	
	r_2	*Pooled Variance Test*	r_3	*Pooled Variance Test*
2*a*. Women who are housewives	†		†	
3. Of those with jobs who work full-time	†		†	
4. Workers employed in manufacturing trades	1·73		†	
5. Of full-time workers who work days	†		†	
6. Workers whose time to work is less than 20 mins.	†		1·24	
7. Who went to pictures in last seven days	2·57	*	1·81	
8*a*. Who own a television set	†		1·44	
8*b*. Who have not watched television in last seven days	†		1·11	
9*a*. Who bet on football pools	1·52		1·33	
10*a*. Who smoke	1·14		1·41	
10*b*. Of men smokers who smoke cigarettes	†		1·39	
10*c*. Of all cigarette smokers who smoke 8 or more cigarettes a day	1·16		1·14	
11. Of those reading a daily paper who read *Daily Mirror*	2·03	*	2·51	*
12. Of those reading a Sunday newspaper who read *News of the World*	1·42		1·52	
13*a*. Who read periodicals regularly	1·53		1·27	
15. Who are reading a book now	1·72		1·23	
16. Who hold a ticket in public library	1·54		1·57	
17*a*. Who had at least one holiday away from home last year	1·14		1·90	
17*b*. Of those having holiday whose holiday was longer than 13 days	1·16		1·47	
18. Who own a bicycle only	†		2·05	*
19*a*. Who own (or whose family own) a car	2·19		3·62	*

‡ If the sampling fraction within clusters is not negligible, it is theoretically possible for a true accuracy ratio to be slightly less than unity, but the discrepancy is negligible here.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Question No. and Percentage for which the Ratios were Calculated (per cent.)	*Clustering Type 2*		*Clustering Type 3*	
	r_2	*Pooled Variance Test*	r_3	*Pooled Variance Test*
20*a*. Who do any gardening	2·53	*	3·13	*
21*a*. Who ever have a drink of beer, wine or spirits	†		†	
22*a*. Who have s sport activity	2·23	*	1·07	
23. Who are married	1·69		2·97	*
25. Who live in a house built or rebuilt since 1945	2·82	*	5·33	*
26. Who live in household with 5 rooms or less	†		2·89	*
27. Who are men	1·83		†	
27. Households with one or more children under 16	1·55		1·36	
28. Of respondents whose age is 20–29 years	2·93	*	3·05	*
29. Of respondents who finished education at 14 years or less	2·22	*	1·78	
30. Of men whose income was less than £7 10*s*. p.w. (of males only)	1·71		1·97	*

† Indicates that the within-cluster variance in Type 2 or 3 is greater than the within-area variance in Type 1 and hence that the estimate of the accuracy ratio is unity.

* Indicates that the within-cluster variance in Type 2 or 3 is significantly less than the within-area variance in Type 1 at the 5 per cent. level, using a pooled-variance test.

4.4. *Discussion of results.* On some of the questions, particularly in the early part of the questionnaire, the within-cluster variance for the Type 2 or 3 sample is actually greater than the within-area variance for the Type 1 sample, which indicates that for these questions there are no losses of accuracy due to the type of clustering concerned. On most of the questions, however, one or both of the accuracy ratios is greater than unity, and this implies that the variance of an estimate based on the clustered sample is higher than for the estimates based on a scattered sample. In the majority of cases the accuracy ratio for clustering Type 3 is greater than for Type 2, which shows that the reduction of cluster size has generally had the effect of increasing variance. However, there are fairly large fluctuations of the two ratios relative to one another, and this suggests that our experiment was not sufficiently sensitive to measure the ratios very accurately. The suggestion is borne out by the fact that all values of r_1 and r_2 which correspond to significant variance ratios are 1·97 or greater. It would clearly have been desirable to have established as significant, values of r_1 and r_3 a good deal smaller, but this would have required a much larger sample of clusters than our resources permitted.

High values for both types of clustering are found on questions 7, 11, 19, 20, 25 and 28, connected with cinema-going, newspaper readership, car ownership, gardening, housing and age. The highest values occur on question 25 and this is not surprising since post-war houses have usually been built together in blocks or groups instead of being scattered individually over wide areas. The high value of question 20*a*, concerned with gardening, is also easy to explain since houses with gardens tend to occur together in groups. The result on question 19*a* is presumably due to the fact that car ownership is related to income and households with higher incomes tend to live relatively close together. It may be noted that the income question 30 also shows fairly high values of r_2 and r_3. The results on question 11 suggest that there is some correlation within clusters of *Daily Mirror* readership. The high values on the remaining two questions—7, which is concerned with cinema-going, and 28, which is concerned with the number of respondents aged 20–29—are not easy to explain. Neither are the fairly high values on question 23 which deals with the percentage who are married.

Questions with low values are 2, 3, 5, 10 and 21, concerned with women who are housewives, jobs which are full-time, workers who work days, smoking habits and drinking; these are characteristics which one would expect to be fairly uniformly distributed over the areas.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

By relating these values of the accuracy ratios to the cost figures given in the last section we can form an impression of the relative efficiencies of the three types of clustering, but the matter is not as simple as it might at first sight appear, for two reasons. First, in an ordinary survey the towns or areas would have been selected as first-stage units in a two-stage sampling process, and thus in addition to the within-area variance, which is all that has been considered here, there would be a first-stage component of variance unaffected by the type of clustering used. Secondly, we have only taken into account costs due to interviewers' time in the field, whereas in an ordinary survey these only represent a fraction of the total costs. Thus, if we take as an overall measure of efficiency the reciprocal of the product of total cost and overall variance, a knowledge of the product of within-area variance and interviewing cost under various types of clustering does not enable us to evaluate the overall efficiencies of these types. Consequently, in order to calculate measures of efficiency, we need to know or to assume values of the ratios of between-area variance to the within-area variance, and of interviewers' time costs to total costs, which are likely to be found in actual surveys. The measures will necessarily be very rough since these ratios will vary according to the kind of survey under consideration. Moreover, since our figures relate to urban interviewers we can only consider the urban part of the population. Thus the discussion in the remainder of this section can only be regarded as illustrative of the way in which the within-area costs and variances influence overall efficiency.

We shall consider a survey in which a first-stage sample of areas has been taken and a second-stage sample of Type 1 of individuals within areas, and in which the overall variance is about twice what it would have been if the individuals had been selected at random in a single-stage sample from the entire population. This implies that the between-town component and the within-town component of the overall variance are about equal. Consequently, if a clustered sample of accuracy ratio r is introduced at the second stage the overall variance is increased in the ratio $1 + r : 2$. For the cost ratio we assume that interviewers' time costs represent about half of the total costs. Thus if interviewing costs in the clustered sample are a fraction c of the costs in the Type 1 sample, total costs are reduced in the ratio $1 + c : 2$.

Taking as our measure of efficiency the reciprocal of the product of overall variance and total costs, the ratio of the efficiency of the clustered sample to the unclustered sample is

$$\frac{4}{(1 + r)(1 + c)}.$$

For Type 2 samples c is about $\frac{2}{3}$, so in order that they should lead to an improvement in efficiency we must have

$$4 > (1 + r)\frac{5}{3}, \text{ i.e., } r < 1{\cdot}40.$$

For Type 3 samples c is about $\frac{4}{5}$ so that if they are to be more efficient than Type 1 samples we must have

$$4 > (1 + r)\frac{9}{5}, \text{ i.e., } r < 1{\cdot}22.$$

An indication of the kind of question on which one could expect a gain of efficiency may be obtained by comparing these values with the values of r_1 and r_2 in Table 11. It will be seen that these values, 1·40 and 1·22, are not very different from the values 1·50 and 1·25 that would have been obtained by neglecting the first-stage component of variance and the non-interviewing costs. Thus in this illustration we should not have been seriously in error by using the simpler approach. However, it has been necessary to go into the matter at some length since this will not generally be true.

In any case it is clear that, so far as the results of this experiment are concerned, Type 2 samples are more efficient than Type 3 samples. Even for Type 2 samples, however, a moderate correlation in the replies from individuals in the same cluster is sufficient to bring about an increase of variance which more than offsets the reduction in costs due to the clustering of interviews. Although the estimates presented in Table 11 are subject to sampling errors, they suggest that Type 2 variance

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

has been large enough to offset cost reductions in rather more than half the questions analysed, on the cost assumptions made for the purpose of illustration.

It must be remembered that in this experiment polling districts were selected at random. The efficiency of cluster samples could be improved by stratification of the polling districts by a criterion such as the J index described by Gray and others (1951). We cannot judge how great this improvement would be, since the resources available to us did not permit the investigation of this point without the sacrifice of some other objective.

5. *Interviewer Variability*

It is important that in experiments of this kind the opportunity should be taken of comparing the performance of different interviewers working under similar conditions, since although interviewer variability is a matter of great concern to survey practitioners it is usually difficult to make satisfactory comparisons in an ordinary survey. Since our experiment was designed in such a way that in each area the two interviewers from the same organization had independent assignments on the same type of clustering, we were able to compare the variance between interviewers with the random sampling variance. In this part of the analysis we included the B.I.P.O. interviewers; thus there were 21 pairs of interviewers available for the comparisons. These were made for response rates, for check card return rates and for the replies to the questions.

(a) *Response rates.* We first examined the response rates obtained by the different interviewers. In order to put the results from clustering Types 1, 2 and 3 on the same footing, each interviewer's assignment on Type 1 was divided into two groups of 15 attempted interviews. In one area, let p_{11} and p_{12} denote the proportions of successful interviews obtained by an interviewer in his two groups of interviews, and let p_{21} and p_{22} similarly denote the proportions obtained by the second interviewer working on the same type of cluster in that area. On the null hypothesis that there are no systematic differences between interviewers, p_{11}, p_{12}, p_{21} and p_{22} are independent observations from the same binomial population. Thus the quantity

$$F = \frac{\Sigma\ (p_{11} + p_{12} - p_{21} - p_{22})^2}{\Sigma\ (p_{11} - p_{12})^2 + (p_{21} - p_{22})^2},$$

where Σ denotes summation over the six areas, will be distributed approximately as the variance ratio with (7, 14) degrees of freedom.

The values of F obtained for clustering Types 1, 2 and 3 were 1·04, 3·54 and 3·00 respectively. The value required for significance at the 5 per cent. level is 2·77. Thus Types 2 and 3 show significant differences between interviewers and Type 1 does not. If the results are pooled over the three types on the assumption that the samples are independent we obtain a significant value for F of 2·48 based on (21, 42) degrees of freedom.

Although the results from Type 1 do not show large differences, it must be remembered that the samples of interviewers are small, so that the values of F are subject to large sampling fluctuations. Taking the results of the three clustering types together, we have significant evidence that the differences in the response rates obtained by different investigators are not attributable to chance.

(b) *Check cards.* We thought it desirable to send a check card to each successfully interviewed informant in the random samples. There were two reasons for this. First, the return of the card gave a check on the interviewer's honesty; secondly, it gave informants an opportunity of complaining about the last question of the questionnaire, concerned with times at home. The overall rate for the return of the check cards was 70·1 per cent., which was rather higher than is usual, and no case emerged of an interviewer having dishonestly recorded an interview or of a complaint concerning the last question. First we carried out an analysis of variance on the return rates of the individual interviewers, and this showed that there were no significant differences between areas or between organizations. We then analysed the between-interviewer variation of the return rates in a similar way to our analysis of the response rates described under (a), and the values of F obtained for Types 1, 2 and 3 were 2·03, 1·94 and 0·61 respectively. None of these was significant, nor was the pooled value of 1·43 for the three types combined. Check card return rates did not, therefore, show significantly greater variation than would be expected from chance fluctuations.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(c) *Replies to questions.* The replies obtained to the individual questions were analysed in a similar fashion. For Type 1, however, the variance ratio was obtained in the following slightly different way to avoid the necessity of dividing each interviewer's assignment into two parts and tabulating their results separately. Let p_1 and p_2 denote the proportions of respondents possessing a certain attribute obtained by the two interviewers in a particular area. Then the variance ratio was estimated by

$$F_1 = \frac{\Sigma (p_1 - p_2)^2}{\Sigma \left(\frac{p_1 (1 - p_1)}{n_1 - 1} + \frac{p_2 (1 - p_2)}{n_2 - 1} \right)}$$

where n_1 and n_2 are the numbers of respondents on which p_1 and p_2 were based. F_1 is distributed approximately as the variance ratio with 7, $\Sigma (n_1 + n_2 - 2)$ degrees of freedom.

The ratios F_2 and F_3 for Types 2 and 3 were calculated in a manner similar to that for the response rates under (a) above. Thus

$$F_2 = \frac{\Sigma (p_{11} + p_{12} - p_{21} - p_{22})^2}{\Sigma (p_{11} - p_{12})^2 + \Sigma (p_{21} - p_{22})^2}$$

where the p's now denote the proportions possessing the attributes in the four clusters in a particular area. F_3 is calculated similarly. F_2 and F_3 are distributed approximately as the variance ratio with (7, 14) degrees of freedom.

The results are given in Table 12.

TABLE 12

Ratios of Between-interviewer Variance to Random Sampling Variance

Question No. and Proportion for which the Ratios were Calculated (per cent.)	F_1	F_2	F_3
2*a*. Women who are housewives	0·61	1·84	1·71
3. Of those with jobs who work full time	0·89	0·76	0·32
4. Workers employed in manufacturing trades	0·55	0·42	0·47
5. Of full-time workers who work days	0·96	1·08	1·05
6. Workers whose time to work is less than 20 mins.	1·60	1·63	1·58
7*a*. Who went to pictures in last seven days	0·84	0·92	0·77
8*a*. Who own a television set	0·76	1·08	1·04
8*b*. Who have not watched television in last 7 days	5·36*	3·95*	1·41
9*a*. Who bet on football pools	1·22	0·32	1·83
10*a*. Who smoke	1·43	1·74	0·83
10*b*. Of men smokers who smoke cigarettes	0·91	0·73	0·42
10*c*. Of all cigarette smokers who smoke 8 or more cigarettes a day	0·67	0·42	1·26
11. Of those reading a daily paper who read *Daily Mirror*	1·61	1·54	1·37
12. Of those reading a Sunday newspaper who read *News of the World*	1·34	0·77	0·58
13*a*. Who read periodicals regularly	1·50	0·32	0·27
13*b*. Of those reading periodicals who read Picture and General Entertainment type	0·96	0·48	2·25
15. Who are reading a book now	0·86	0·77	0·26
16. Who hold a ticket in public library	0·64	0·92	1·45
17*a*. Who had at least one holiday away from home last year	0·90	1·19	0·56
17*b*. Of those having holiday whose holiday was longer than 13 days	2·01	0·93	0·39
18. Who own a bicycle only	0·51	3·84*	0·85
19*a*. Who own (or whose family own) a car	0·86	0·55	0·15
20*a*. Who do any gardening	1·13	0·72	2·02
21*a*. Who ever have a drink of beer, wine or spirits	1·14	1·64	0·87

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Question No. and Proportion for which the Ratios were Calculated (per cent.)	F_1	F_2	F_3
22*a*. Who have a sport activity	1·35	1·50	0·54
23. Who are married	1·10	4·37*	1·25
25. Who live in a house built or rebuilt since 1945	0·50	1·99	5·14*
26. Who live in household with 5 rooms or less	0·82	0·19	5·41*
27. Who are men	0·95	1·19	0·49
27. Households with one or more children under 16	1·00	1·22	3·56*
28. Of respondents whose age is 20–29 years	0·69	1·10	0·16
29. Of respondents who finished education at 14 years or less	2·52*	0·70	0·56
30. Of men whose income was less than £7 10*s*. p.w. (of males only)	0·68	1·61	1·47

* Indicates that the ratio is significant at the 5 per cent. level.

It will be seen from the table that significant ratios are few, there being only two for each of Types 1 and 2, and three for Type 3. The two significant ratios which arose in question 8*b* are attributable to the fact that, despite instructions to ask this question (on television watching) of all respondents, a few interviewers tended to ask it only of those possessing a television set (question 8*a*) and to code "zero" for the number of nights watched for all other respondents. Thus on this question there is clear evidence of between-interviewer variation, but it is probably due to faulty questionnaire design or inadequate briefing rather than to fundamental differences between the interviewers.

Eliminating this question, we are left with five significant values out of 96, which is almost exactly the number to be expected if there were no real interviewer differences. Moreover, the values of the ratios for each of the three types of samples occur with almost equal frequencies above and below unity. 14 values of F_1 were greater than unity, 17 values of F_2 and 16 values of F_3, in each case out of 33 questions analysed.

We are therefore left with a strong impression that, at least for the factual type of questions we have used, the variability between interviewers in replies obtained is so small compared with random sampling fluctuations that it can reasonably be neglected.

In a previous enquiry using a similar questionnaire, Moser and Stuart (1953) commented on the large variability between quota sample interviewers, and wrote: "it seems to us beyond question that the greater part of [quota sample] between-interviewer variability found in this experiment is due to selection differences . . . for random samples [the between-interviewer variability] is likely to be small". Table 12 of the present paper confirms this view. In random sampling, where the interviewer has no selection initiative, between-interviewer variation does not seem to be important; the implication for the quota sample findings is that the much greater variation found there can almost certainly be attributed to the latitude in selection permitted to quota sample interviewers.

6. *Conclusions*

In stating our conclusions from the non-response part of the experiment, it must again be emphasized that our standard of comparison has throughout been the result obtained by making unlimited recalls on the originally selected respondents.

Judged by this standard, the sample of interviews obtained at the first call was badly biased on some of the questions.

The method of reweighting the first call results by the reciprocals of the estimated probabilities of respondents being found at home, which was suggested by Politz and Simmons as a means of correcting these biases, has not appreciably improved the results. However we did not give the method a fair trial, since most of our first calls were made during the day, when a large proportion of the population has a negligible chance of being found at home. But there seem to be no practical difficulties in using the method and it would be interesting to see its performance tested against an all-calls sample under more favourable conditions.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Another method for compensating the first-call biases, which we tested, involved the replacement of non-respondents at the first call by a matched quota sample based on information collected at that call by the interviewers. The results of the composite sample thus obtained did not justify the additional cost incurred; and even when the quota sample replacement was made after the second or third call, the results were still inferior to those of the random sample based on three calls.

The three-call random sample alone gave results which were satisfactorily close to those of the all-calls sample. Our experiment therefore lends support to the practice, common in this country, of making only three calls. However, it must be remembered that the all-calls sample is itself subject to biases owing to the fact that interviews cannot be obtained, even with unlimited recalls, from a substantial fraction of the population under study, and that any such biases would also be present in the three-calls sample.

In the part of the experiment concerned with the effects of different types of clustering we found that the result of concentrating the interviews into polling districts was to reduce interviewing costs by about one-third. Rather surprisingly, further concentration into street clusters increased interviewing costs above those for polling district clusters, although not to the level of the randomly scattered sample.

On most questions, both types of clustering led to increases of sampling variance, the increase being greater for street clusters than for polling district clusters. Thus, from both the cost and variance standpoints, polling district clusters are to be preferred to street clusters. However, under different field work conditions from those we considered, the street cluster method might put up a better performance.

Our discussion of overall efficiency showed that even polling district clusters can lead to a net loss on many questions owing to the increases of variance, but it must be remembered that this may not hold if the polling districts are stratified before selection.

Perhaps the most striking of our results were those on interviewer variability. Although there were significant differences in the response rates obtained by different interviewers working under similar conditions, the differences in the replies they obtained to the questions were, on the whole, no greater than the random sampling fluctuations. In other words the difference in the results obtained by two different interviewers working on separate sets of respondents seems to be no greater than the difference which would have been obtained if the same interviewers had worked on both sets.

It must be remembered that the questions asked in the experiment were simple and factual, and the conclusions reached, particularly about interviewer variability, do not automatically carry over to more difficult types of questions. However, interviewer variability in general is a complicated subject the study of which needs greater resources than could be devoted to it in an experiment primarily concerned with non-response and clustering.

References

DEMING, W. E. (1953), "On a probability mechanism to attain an economic balance betweeen the resultant error of response and the bias of non-response", *J. Amer. Statist. Assoc.*, **48**, 743–772.

DURBIN, J. (1953), "Non-response and call-backs in surveys", Paper read at the 28th Session of the International Statistical Institute, Rome, 1953. To be published in the *Bulletin* of the Institute.

GRAY, P. G., & CORLETT, T. (1950): "Sampling for the Social Survey", *J. R. Statist. Soc.*, A, **113**, 150–206.

—— —— & FRANKLAND, P. (1950), *The Register of Electors as a Sampling Frame.* Social Survey Report, Central Office of Information, London.

—— —— & JONES, P. (1951), *The Proportion of Jurors as an Index of the Economic Status of a District.* Social Survey Report, Central Office of Information, London.

HANSEN, M. H., & HURWITZ, W. N. (1946), "The problem of non-response in sample surveys", *J. Amer. Statist. Assoc.*, **41**, 517–529

HARTLEY, H. O. (1946), Contribution to discussion of a paper read by F. Yates in *J. R. Statist. Soc.*, A, **109**, 12-43.

MOSER, C. A. (1952), "Quota sampling", *J. R. Statist. Soc.*, A, **115**, 411–423.

—— & STUART, A. (1953), "An experimental study of quota sampling", *J. R. Statist. Soc.*, A, **116**, 349–405.

POLITZ, A., & SIMMONS, W. R. (1949), "An attempt to get the 'not-at-homes' into the sample without call-backs", *J. Amer. Stat. Assoc.*, **44**, 9–31.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPENDIX "A"

SURVEY RESEARCH UNIT LEISURE SURVEY 2

Interviewer's No. ...../...../...../.....

S.R.U. 33

Serial No. of Informant .....

---

1 (a) I am from the Survey Research Unit, and we are trying to find out a few things about what people do in their spare time. Would you mind telling me, are there any things which you would like to spend more time on?

Yes	1
No	2
Don't know	3
	0

(b) *If "YES" to Q. 1(a)*: What, for instance? (*Record Fully*)

.....

.....

.....

ASK QUESTION 2(a) OF ALL WOMEN INFORMANTS. FOR MEN GO ON TO QUESTION 3.

2 (a) Are you a housewife—That is, the person who is mainly responsible for domestic duties in your household?

Yes	1
No	2
Not applicable	3
	0

IF "YES" TO QUESTION 2 (a):

2 (b) Do you have any paid help with the housework, such as a charwoman or a home help?

Yes	1
No	2
Not applicable	3
	0

ASK ALL INFORMANTS

3. I know that having a job makes a lot of difference to the amount of spare time you get, so would you mind telling me whether you have a paid job, and whether it is full-time or part-time? (Part-time means less than 30 hours per week.)

Has full-time paid job	1
Has part-time paid job	2
Has no paid job	3
	0

ASK QUESTIONS 4, 5 AND 6 ONLY OF INFORMANTS WITH PAID JOBS. FOR THOSE WITHOUT JOBS GO ON TO QUESTION 7 (a)

4. What is your job?. (*Obtain fullest possible description of occupation and industry.*)

Occupation (*Give type of work done*) For Office Use

Y X 0 1
2 3 4 5
6 7 8

.....

.....

Industry (*Give nature of employers' business*) Y X 0 1
2 3 4 5
6 7 8

..... Not applicable 9

5. Do you work days or nights, or are you a shift worker? (*Record as stated.*)

.....

.....

.....

For Office Use

Y X 0 1
2 3 4 5
6 7 8
Not Applicable 9

6. Roughly how long does it take you to get to work? I mean just going to work, not coming home as well. (*Record as stated.*)

For Office Use

..... Y X 0 1
2 3 4 5
..... 6 7 8
Not Applicable 9

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ASK QUESTION 7 (a) ONWARDS OF ALL INFORMANTS

7 (a) When did you last go to the pictures?

Within the last 7 days	1
8–14 days ago	2
15–28 days ago	3
More than 28 days ago	4
I never go	5
Don't know	6
	0

IF "WITHIN LAST 7 DAYS" TO QUESTION 7 (a):

7 (b) How many times have you been in the last 7 days? (*Ring number stated.*)

1 2 3 4
5 6 7 0
Don't know Y
Not applicable X

8 (a) Do you have a Television set in your home?

Yes	1
No	2
Don't know	3
	0

8 (b) On how many evenings have you watched television in the last 7 days? (*Ring number stated.*)

1 2 3 4
5 6 7 0
Don't know Y

9 (a) Are you doing any football pools this season?

Yes	1
No	2
	0

IF "YES" TO QUESTION 9 (a)

9 (b) Do you do them alone or share with someone at home or at work?

Alone	1
Share at home	2
Share at work	3
Other (*Give details*)	4
Not applicable	5
.....	0
.....	

10 (a) Do you smoke at all?

Yes	1
No	2
	0

ASK MEN SMOKERS ONLY

10 (b) Cigarettes or pipe or both?

Cigarettes	1
Pipe	2
Both	3
Other	4
Not applicable	5
	0

ASK ALL MEN AND WOMEN WHO SMOKE CIGARETTES

10 (c) How many cigarettes did you smoke yesterday? (*Record as stated. Number SMOKED is asked for irrespective of when or by whom they were bought.*)

For Office Use

..... Y X 0 1
2 3 4 5
..... 6 7 8
Not applicable 9

11. Did you read any daily morning newspapers yesterday? Which ones? (*If interview is on Monday, ask of previous Saturday.*)
Ring Every Paper Mentioned.

None	Y
Daily Mirror	X
Daily Sketch (*Graphic*)	1
Daily Express	2
Daily Mail	3
Daily Herald	4
News Chronicle	5
Daily Telegraph	6
The Times, Manchester Guardian or both	7
Don't know	8
Others (List below)	9
.....	0
.....	

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

12. Did you read any Sunday newspapers last Sunday? Which ones?
Ring Every Paper Mentioned.

None	Y
News of the World	X
The People	1
Sunday Express	2
Sunday Graphic	3
Sunday Pictorial	4
Sunday Chronicle	5
Sunday Dispatch	6
Reynold's News	7
Empire News	8
Sunday Times, Observer or both	9
Don't know	0
Others (List below)	

.....

.....

13 (a) Do you read any magazines or weekly or monthly papers regularly—that is, practically every time they come out?

Yes	1
No	2
Don't know	3
	0

IF "YES" TO QUESTION 13 (a):

13 (b) Which ones? (*List Fully*)

.....

.....

.....

.....

For Office Use

Y	X	0	1
2	3	4	5
6	7	8	

Not applicable 9

14. Do you remember the author or title of any book you have read recently? (*Record fully.*)

.....

.....

.....

.....

For Office Use

Y	X	0	1
2	3	4	5
6	7	8	9

15. Are you reading any books at the moment?

Yes	1
No	2
Don't know	3
	0

16. Do you hold a ticket in your own name for the public library.

Yes	1
No	2
Don't know	3
	0

17 (a) Have you had a holiday away from home this year, i.e., During 1953?

Yes	1
More than one	2
No	3
	0

IF "YES" TO QUESTION 17 (a):

17 (b) How long were you away? (*State number of nights spent away from home.*)

.....

.....

For Office Use

Y	X	0	1
2	3	4	5
6	7	8	

Not applicable 9

18. Do you have a bicycle or motor-cycle of your own?

Bicycle	1
Motor-cycle	2
Both	3
Neither	4
	0

19 (a) Have you, or has any member of your family living at your address got a car?

Yes	1
No	2
Don't know	3
	0

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

IF "YES" TO QUESTION 19 (a):

19 (b) Have you travelled in it during the past 7 days?

Yes	1
No	2
Not applicable	3
	0

20 (a) Do you do any gardening?

Yes, at least once a week	1
Yes, less than once a week	2
Never	3
	0

IF "YES" (1 OR 2) TO QUESTION 20 (a)

20 (b) Is any of your gardening done on an allotment?

Yes	1
No	2
Not applicable	3
	0

21 (a) Do you ever have a drink of beer, wine or spirits?

Yes	1
No	2
	0

IF "YES" TO QUESTION 21 (a), ASK 21 (b) AND 21 (c)

21 (b) How often do you have it?
Record as Stated.

	For Office Use			
	Y	X	0	1
	2	3	4	5
	6	7	8	
	Not applicable			9

21 (c) Do you usually have it at home or elsewhere?

Home	1
Elsewhere	2
Both	3
Not applicable	4
	0

22 (a) Do you watch or take part in any kind of sport or racing regularly outside your home, that is, at least once a month during the season?

Yes	1
No	2
	0

IF "YES" TO QUESTION 22 (a)

22 (b) Have you done this during the past month?

Yes	1
No	2
Not applicable	3
	0

23. Now I would like to ask you a few details about yourself and your household. Are you married? (*"Divorced" and "Married but living apart" should be coded* "3".)

Married	1
Single	2
Widowed and other	3
	0

24. I would like to ask you about your living accommodation. Would you show me on this card which applies to you?
(*Give card and call by number.*)

Living at home	1
Living as a boarder with a family, having meals	2
Living as a lodger with a family (no meals)	3
Living in a hotel/hostel/boarding house/ hospital/institution	4
Living elsewhere (give details below)	5
	0

IF (1, 2 OR 3) TO QUESTION 24, ASK QUESTIONS 25–27. IF (4 OR 5) TO QUESTION 24, GO TO QUESTION 28.

25. Has the house you live in been built or rebuilt since 1945?

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Yes	1
No	2
Don't know	3
Not applicable	4
	0

26. How many rooms are occupied by your household? (*Exclude scullery, bathroom and hall.*) (Record as stated.)

	For Office Use			
.....	Y	X	0	1
	2	3	4	5
.....	6	7	8	
.....	Not applicable			9

27. Would you mind telling me who are the people living in your household?

Relationship to Informant	Sex	Exact Age if Under 21	Ring if 21 or Over
1 ..... Informant.....	M F		
2	M F		21
3	M F		21
4	M F		21
5	M F		21
6	M F		21
7	M F		21
8	M F		21
9	M F		21
10	M F		21
11	M F		21
12	M F		21

Number in Household aged: 0–4 .....
5–15 .....
16–20 .....
21 and over .....
Not applicable 7 TOTAL

ASK ALL INFORMANTS

28. How old are you? (*Record as stated.*)

.....

For Office Use			
Y	X	0	1
2	3	4	5
6	7	8	9

29. At what age did you finally stop receiving full-time education?

14 or under	1
15	2
16	3
17	4
18	5
19	6
20 or over	7
Don't know	8
Not yet finished	9
	0

30. Do you mind telling me from this card which income group your income last week fell into?

(*Give Card and Call by Number.*)

(a) IF INFORMANT IS WORKING ADD: I mean after deducting income tax and National Insurance, but including overtime and bonuses.

(b) *Housewives' housekeeping money and government family allowance should not be included.*

	Group
None	1
Up to £3	2
Over £3, up to £5	3
Over £5, up to £7 10*s.*	4
Over £7 10*s.*, up to £10	5
Over £10, up to £20	6
Over £20	7
Don't know	8
Refused	9
	0

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

31. Finally, we would like to know how often people are at home. Would you mind telling me whether you were at home at this time:

		YES	NO	DON'T KNOW	
Yesterday	*Name*	1	2	3	0
The day before	*the*	1	2	3	0
,, ,, ,,	*day*	1	2	3	0
,, ,, ,,	*in*	1	2	3	0
,, ,, ,,	*each*	1	2	3	0
,, ,, ,,	*case*	1	2	3	0

For Office Use

Y	X	0	1
2	3	4	5
6	7	8	9

Ring Date of Interview

	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
Sept.	27	28	29	30			
Oct.					1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
Nov.	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21

Check Card Sent:

N.C. :

Name of Informant (*Block Capitals*)

.....

Address of Informant (*Block Capitals*)

.....

.....

.....

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Interviewer's Number ...../...../...../.....

Interviewer's Number ...../...../...../.....

SURVEY RESEARCH UNIT
RECORD SHEET

Serial Number of Informant (1)	First Call		To be filled in if result of First Call is coded 7, 8 or 9			Details of Informant				Removals Substitute (11)	Result of First Call (12)	Second Call		Third Call		Fourth Call	
			Informant's			Serial Number (7)	Sex (8)	Name (9)	Address (10)								
	Date & Time (2)	Result (3)	Sex (4)	Age (5)	Social/income Grade (6)							Date & Time (13)	Result (14)	Date & Time (15)	Result (16)	Date & Time (17)	Result (18)
	Date: ..... Time.....a.m. of call .....p.m.		M F	20–29 ... 1 30–44 ... 2 45–64 ... 3 65+ ... 4 No Information 0	1 2 3 No Information 0		M F			Y		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
	Date: ..... Time.....a.m. of call .....p.m.		M F	20–29 ... 1 30–44 ... 2 45–64 ... 3 65+ ... 4 No Information 0	1 2 3 No Information 0		M F			O		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
	Date: ..... Time.....a.m. of call .....p.m.		M F	20–29 ... 1 30–44 ... 2 45–64 ... 3 65+ ... 4 No Information 0	1 2 3 No Information 0		M F			Y		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
	Date: ..... Time.....a.m. of call .....p.m.		M F	20–29 ... 1 30–44 ... 2 45–64 ... 3 65+ ... 4 No Information 0	1 2 3 No Information 0		M F			O		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
	Date: ..... Time.....a.m. of call .....p.m.		M F	20–29 ... 1 30–44 ... 2 45–64 ... 3 65+ ... 4 No Information 0	1 2 3 No Information 0		M F			Y		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
	Date: ..... Time.....a.m. of call .....p.m.		M F	20–29 ... 1 30–44 ... 2 45–64 ... 3 65+ ... 4 No Information 0	1 2 3 No Information 0		M F			O		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	

Code for Result:

1. Questionnaire completed.
2. Questionnaire partly completed (i.e., interview broken off).
3. Unknown at this address or address non-existent.
4. Removed—no substitute to be taken (see instructions).
5. Removed—substitute to be taken (see instructions).
6. Away from home for long period (i.e., until after the end of field work)—no recall to be made.
7. Away from home for a few days—recall to be made.
8. Out—recall to be made.
9. Too busy or indisposed—recall to be made.
10. Ill or unsuitable for interview—no recall to be made.
11. Deceased.
12. Interview refused.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

Fifth Call		Sixth Call		Seventh Call		Eighth Call		Ninth Call		Tenth Call	
Date & Time (19)	Result (20)	Date & Time (21)	Result (22)	Date & Time (23)	Result (24)	Date & Time (25)	Result (26)	Date & Time (27)	Result (28)	Date & Time (29)	Result (30)
Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of all .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.	
Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m.		Date: ..... Time.....a.m. of call .....p.m		Date: ..... Time.....a.m. of call .....p.m.	

Code for Result:

1. Questionnaire completed.
2. Questionnaire partly completed (i.e. interview broken off).
3. Unknown at this address or address non-existent.
4. Removed—no substitute to be taken (see instructions).
5. Removed—substitute to be taken (see instructions).
6. Away from home for long period (i.e. until after the end of field work)—no recall to be made.
7. Away from home for a few days—recall to be made.
8. Out—recall to be made.
9. Too busy or indisposed—recall to be made.
10. Ill or unsuitable for interview—no recall to be made.
11. Deceased.
12. Interview refused.

Discussion on the Paper by Mr. Durbin and Mr. Stuart

Mr. J. L. Nicholson: The authors of this paper have chosen an important and interesting subject for investigation, and have carried it out with such exemplary efficiency that they have left little room for useful comment, and even less for criticism. Since I shall, nevertheless, risk making a few criticisms, I should like to make it clear right away that I have not found it at all easy to find any flaws, and only put forward these points in the belief that the authors would regard criticism as the most useful form of comment.

They have emphasized that the standards of comparison in all cases are the results obtained by persistent re-calling. If a great deal of persistence is needed in order to get replies, this may itself have some influence on the replies obtained. A person who is relentlessly pursued by an indefatigable interviewer may eventually decide that the easiest way out is to give any answers that come into his head; he may even become thoroughly perverse and deliberately give wrong answers. This is one possible source of bias. But, quite apart from this, it appears from the results of the survey that a substantial proportion of people can never be tracked down to earth, however

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

persistently one tries. The authors have deliberately excluded any consideration of this hard core of unapproachables. But unless we get *very* high response rates, the results of any enquiry of this kind may be of little value if those who may be termed recusants have quite different habits from other people. It becomes very important, therefore, to get any clues we can as to who these people are.

It seems a pity that the experiment was not designed to throw—even if it could only be—a dim, flickering light on a problem that must worry nearly every social survey investigator. What we would like to know is whether people who are difficult, or impossible, to get at are different from other people in any of the characteristics which are likely to have an important bearing on the results of such surveys. Do they, for example, belong to different economic or social groups? Do they tend to belong to small families? Do they live in towns? Do they own cars or television sets? Comparisons between the R_3 and R_T samples might have given us some sort of clue. The answers to some of these questions—whether they have at least a garage or television aerial—could have been obtained without interviewing anybody. The results of the present experiment contain a suggestion (cf. the figures from the R_1, R_3 and R_T samples in Table 4) that the difficult people to get at are people who have recently moved house, sportsmen and football pool addicts.

The authors have in effect assumed that the results of the all-calls sample apply to the sample as a whole, including recusants. But it may be that these tough nuts have more in common with the people who can only be got hold of after more than (say) 3 calls, than with those who are found more easily. Different conclusions would be obtained if the results for calls after the third were assumed to apply to recusants as well. If the results were reweighted on this assumption, the differences between the R_1, R_3 and R_T samples would become larger; and I suspect that the answers to most of the questions in Table 4 would then show significant differences. We do not of course know if such reweighting is justified or not.

A method which has been successfully used in at least one other enquiry is to work intensively on a sub-sample of those who are non-respondents after one or two calls. This method seems to me to have some advantages over the method of unlimited calls, since it lightens the burden of the interviewer, who might then be encouraged to make greater efforts, or at least not to give up in despair after making numerous calls. At any rate one stands to lose very little; and one might even make some inroads into the hard core of refusals. Mr. Durbin's arguments about costs, in a recent paper on this subject, have some force, but are confined to cases where interviews have been obtained by the usual methods without recourse to sub-sampling. It may be worth going to much greater costs to obtain information from those who would otherwise become non-respondents.

But my main point is that every effort should be made to obtain the kind of information about the ultimate non-respondents which could be used at least for classifying and reweighting the results obtained from the rest of the sample.

An interesting conclusion of the present experiment is that the results based on 3 calls appear to be a good deal better than the results obtained by combining the 3-calls sample with a quota replacement of the remainder. In 25 cases out of 32, the former gives results which are closer to those of the all-calls sample. So far from being improved, the results are actually made worse by the inclusion of the quota sample—assuming, of course, that the all-calls sample can be accepted as a fair standard of comparison.

The Politz-Simmons method of reweighting the results by the reciprocals of estimates of the probabilities of finding people at home also comes out badly; but this is not surprising since the probabilities were very crudely estimated. It would really be necessary to know not only how many days of the week the people interviewed were at home at the time of the interview but also the amount of time which they spent at home each day, on which it would clearly be very difficult to get accurate information.

I am somewhat uncertain about the object of the substitution method, described in Section 2.6. It seems doubtful whether the results would be improved by this method, unless the people who have recently moved into a house have similar characteristics to those who have recently moved out of a house. One could only find this out by obtaining information from the people who have moved out; which one could only do by tracking them down.

Perhaps the most important results of this experiment are those relating to clustering. Although the authors do not quite get to the point of saying so, neither of the two kinds of clustering which were tried seems to have produced any gain in efficiency. Even clustering by polling districts does not seem to produce any improvement, and clustering by streets causes a loss in efficiency.

The Division of Research Techniques has been responsible for quite a number of experiments in social survey techniques, but I think this is the most interesting one they have so far attempted. It is not the fault of the authors that the results are, perhaps, more or less what one would have expected. In moving the vote of thanks, I would like to congratulate them on a very able piece of work.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Dr. NUTTALL (in seconding the vote of thanks): It gives me great pleasure to join Mr. Nicholson in his tribute to the authors of this paper, which now takes its place in what has become a notable sequence of papers emerging from the Division of Research Techniques in recent years.

Many of us heard Professor Kendall recently address the Market Research Society on the work of the Division. We were impressed there by his insistence that the Division's work should be useful and should relate to the problems faced by statisticians who work in the social and business fields. This paper once more confirms that the practice of the members of the Division lives up to that aim. The general standard of the papers is high, and I have a feeling that the Division does not know that its work is regarded as authoritative in this branch of statistics, where the results of carefully controlled experiments of this nature are less commonly published than one would wish. Because of this reputation, a great responsibility rests on those members of the Division who put on record the results of their experiments. They cannot afford to let their heads nod for one moment.

For the same reason criticism must be, perhaps, harsher than that one would give to work done elsewhere.

Let me give an example of what I mean. The authors have produced one result of great practical value, which can be applied immediately by all interested operators. I refer to the result of work on clusters. The information on interviewer cost in particular is rare in a British paper, and is to be commended. On the other hand, the result of the experiment on the Politz-Simmons method is inconclusive. The paper will not always be read to a sympathetic and expert audience, and the authors should realize how this lack of conclusion is capable of being taken out of its context and interpreted as implying that the Division of Research Techniques have tried out this method, and that the method has failed; whereas the true position is that things remain much as they were in this respect. It would have been better to have omitted this facet of the experiment from the paper, reserving the judgment of the Division until an experiment could be devoted to this question alone.

I will now take up the question of the logic of the experiment. The authors' definition of non-response is very limited, their population being confined to those people who are on electoral rolls and are capable of being interviewed. The subsequent sub-experiments are only partially concerned with this main population, one at least being concerned with fundamental methods of sampling from electoral rolls. While this last experiment turned out to be most useful, I feel the logic should have carried the authors on to a consideration of the much more intractable problem of what to do about those people whose names appear on the electoral rolls but who cannot be found, or being found are not interviewable. This problem might well have yielded before an academic onslaught.

In general, I think it is a criticism of the paper that the authors may not successfully have balanced the design of the experiment with the resources available. The main purpose was to test the improvement in results arising from unlimited calls. To this they add (1) an experiment in three types of clustering, (2) an experiment in quota replacement, (3) an attempt to use the Politz-Simmons method. No one doubts the powers of statistical method, but there is a real danger that an over-elaborate design can be applied in such a way that no significant differences emerge at the end. The Division must have, from its previous experiments, sufficient knowledge of the population variances to attain the balance I should have wished them to attain.

Of course, what they *have* done should be a lesson to most commercial statisticians, whose resources are large, but whose time is limited, and who tend as a result to attempt a solution to one question at a time. We could all try to plan our experiments better and to exhaust the results more than we do.

In contrast, I think the authors could gain something from what we like to think is our single-mindedness of purpose.

This shortage of resources has occasionally led the authors into difficulties. I would particularly draw attention to their treatment of the cluster in Stoke Newington which turned out to be among a home for aged people. They have excluded this from their results. Surely this is the negation of the random process? The results should have been allowed to stand and make their contribution to the variance. This problem confronts most statisticians. In drawing samples of shops for examination of the characteristic "in stock", and using a regional stratification, it is not uncommon to find all selected shops in one region out of stock. It might seem that the results for this region should be adjusted in some way, for it might be absurd to say that all the shops in the region were out of stock. But this temptation should be resisted when making national estimates of the characteristics being measured.

If the authors had been drawing ten time as many clusters I feel sure they would not have been so hasty in excluding this particular one.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Turning to the questions asked by the interviewers, the list appears to be almost a lucky dip, though I am sure this is not so. These proving types of surveys are most important pieces of work, and the design of the experiment must include consideration of the question to be asked. There is probably as yet an insufficient body of experience to lay down principles for the form of question to be used, but I am sure such principles exist. It would be interesting to hear the authors' views on this subject. Probably in the random sample it matters less than the quota replacement. But those with experience of quota sampling know how close the inter-relation is between the form of the question and the design of the quota.

I will now return to the Politz-Simmons method, which seems to offer such advantages to operators. The organization to which I belong carried out an equally inconclusive pilot survey of this method, in the spring of last year, some isolated results of which I propose to give as a further illustration of some of the difficulties involved.

The experiment was designed to measure one characteristic only. A sample of 285 adults was chosen from the electoral roll of one town, using interval sampling with a random start. A maximum of three calls per individual was made. For each successful call, a history of the respondent's in/out behaviour was obtained. 109 such interviews were made. We, too, had investigators used to working during the day, but we allocated calls on the basis of daytime interviews for names which were apparently those of housewives, and evening calls for the rest.

The distribution of the 109 interviews by time of beginning the interview was:

	Men	*Women*
9 a.m.–5 p.m.	9	48
5 –6	—	10
6 –7	6	9
7 –8	11	7
8 –9	5	4
	31	78

Even with our method of timing we have a sample of first calls which is deficient in men. We would expect that the same pattern emerged from the authors' survey.

The pattern of the "at homes", and their possession of the measured characteristic was:

	Number	*Possessing characteristic*	%
At home at time of interview in past 7 days	44	4	9
6 ,,	24	4	17
5 ,,	20	2	10
4 ,,	8	2	25
3 ,,	7	—	—
2 ,,	3	1	33
At home on day of interview	3	—	—

This gives a weighted average of 11 per cent. It illustrates how with this method, the larger weights are given to the classes in which smaller numbers occur. There is some evidence from the table above that the possession of the characteristic increases as respondents are at home less. This is confirmed by the analysis of the complete sample after three calls.

Number interviewed	*Possessing characteristic*	%
1st call 109	13	12
2nd ,, 77	17	22
3rd ,, 16	4	25

The weighted average here is 17 per cent., and illustrates how in this example the Politz method has given a poorer result because of the small size, and therefore the large sampling variability, of the groups which are least at home.

It also illustrates how, when adopting this method, care must be taken to see whether the characteristic to be measured is correlated with the degree of being out and about, and that an adequate sample size is planned, as was not the case with the pilot investigation from which I have quoted. It would be interesting to learn how far the authors' experience, both on this survey and one other with which they have recently been associated, bears out these remarks.

In conclusion, might I, in once more congratulating the authors, suggest to them that they might lift their eyes to problems outside the field of limited public opinion research. The problems of sampling for human behaviour are not, as the authors would be the first to admit, entirely in this

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

field of verbal choices. A whole range of problems awaits attention, from the examination of human behaviour in economic situations, to sales testing and perhaps the development of the use of decision functions in business management. They will find as much willing co-operation from those immersed in these cloudy waters as they have had in the past few years from the public opinion research organizations, to which we should all be grateful for making their time and interviewer strengths available for the common benefit.

The vote of thanks was put to the meeting and carried unanimously.

Mr. P. G. GRAY wished to deal with the two main subjects of the paper in turn. First, non-response.

The group with which they were concerned were the people who were not at home when the interviewer called. He was glad to see that the authors had decided that the best way of dealing with this problem was the one the Social Survey had been using for quite a few years, but he would point out that the "3-call method", as they interpreted it, was not quite the same as the one used by the Social Survey. The authors spoke of a "*limit* of three calls". The Survey's practice was to insist on a minimum of three calls—no limit was imposed. The authors referred to the paper which Mr. Corlett and he read to the Society in 1950; but there it was stated clearly: "Investigators are encouraged to make more than three calls where a further call would appear likely to produce an interview."

This distinction between a *limit* of three and a *minimum* of three was quite important in practice. He (the speaker) had a note on the proportion of the sample interviewed after successive calls on one of the Social Survey's ordinary surveys made under the "minimum of three" rule. It used administrative areas at the first stage and individuals from the electoral register at the second and was therefore comparable with the authors' Type 1 sample. Both the proportion achieved after a given number of calls and the proportion got at calls *after* the third were almost identical with the results of the so-called "unlimited recalling" in their "Type 1 sample."

Proportion of Sample Achieved

	Authors' Type I including substitutes for removals (per cent.)	*The Social Survey Sample (no substitutes for removals)* (per cent.)
After—		
1 call	30	30
2 calls . . .	61	60
3 calls . . .	69	70
4 calls . . .	73	72
5 calls . . .	74	73
All calls . . .	75*	74
Sample size . . .	360	2000

* 71 per cent. without substitutes for removals.

It will be seen that the Social Survey did go on recalling after 3 calls, but with *that* sample there still remained 2½ per cent. who still could not be found at home. What happened to these people in the authors' sample? Their system of precodes did not allow for this possibility and one is led to suspect that these residual "not-at-homes" were squeezed into one of the other precodes and perhaps contributed, as the authors suspected, to the apparent "high refusal rate" at later calls.

But the relatively high refusal rate at *earlier* calls still puzzled the authors, and they could not suggest why it should have been higher this time than in their last experiment. The speaker did not find this difference so surprising. On this occasion investigators were instructed to obtain at the first call for all people not interviewed at the first call, "whatever information they could about the age-group and income grade of the informant." Income was a difficult subject which the Social Survey normally left to the end of the interview. This itself could well lead either to immediate refusals by proxy or to refusal by the individual himself when he was finally tracked down. But the authors had once again thrown away their chances of identifying such an effect by their persistence in the use of *precodes* in classifying reasons for non-response. What one would like to know was "*who* refused the interview?" but the precode just said "interview refused" and one could get no further. This was another instance of the mistaken use of precodes for which Mr. Corlett had taken the authors to task after their first paper.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

With regard to the "*quota replacement*" method, it was to be wondered why the authors bothered with it since, as they themselves said, it "cannot be expected to lead to an improvement in accuracy". All it seemed to have done here was to spoil another part of the experiment. Incidentally, the authors had so far neglected the opportunity of making some rather interesting comparisons between the people interviewed at second or later calls and the "quota" subjects intended to replace them.

As for the Politz-Simmons method, the cheerful optimism with which the authors accepted such a bad result and assumed that all would be well with interviewing confined to the evening, was rather surprising. It might be, of course, that their bad result was entirely due to the high proportion of their sample who had "zero probability" of being found in at a first call; but this was not necessarily the whole story. The authors were justifiably pleased at the high proportion of people who answered their "were-you-at-home" question, but this did not mean that the question produced the information wanted or that it was answered correctly. The most useless of one's questions often produced the highest response. He (Mr. Gray) would be glad of an explanation why the authors added one day to the Politz-Simmons series and used data about 7 days and not 6. And, again, any 7 consecutive days include a Sunday: did this mean that for this experiment interviews were made on Sundays and at the same rate as on week-days? (The interviewing seemed to be spread over 12 days not 14.) If not, surely behaviour on Sundays would be entering into their weights but *not* into the actual probability of finding a person at home. (He would like to ask the same question of Dr. Nuttall since his figures related to seven days.) One effect of this would be to narrow the difference in weight between a full-time worker and a housewife, and so give housewives too great a relative weight in the weighted results.

One final point on non-response, that was, the *other* type of non-response considered by the authors—those who had moved from their registered address. He was a little worried by the substitution-procedure suggested since it could so easily lead to abuse by the interviewers. He would also agree with Mr. Nicholson that no proof had been given that the substitutes correctly represented those who had moved.

Turning now to the second subject of the paper *clustering*—those results were very interesting —the only pity was that they were not based on a larger sample. They of course pointed to the necessity of stratifying one's polling districts by something related to income. The Social Survey had used both whole administrative districts and polling-districts in their designs—but they would not normally consider using areas smaller than polling districts. He had a horrible vision of what might happen with a street-cluster of 15 houses and a *limit* of 3 calls. This condition would be met if the time between calls was only the time taken to walk up and down the street—with such a clustered sample, what constituted "a call"?

Finally, he was not too happy about the assumption in the authors' calculation after Table 11 that the between-administrative district contribution to the variance was as large as the within. From the Social Survey's experience he would suggest that in a stratified design it was appreciable less than this—in which case the results would favour more strongly administrative districts.

In spite of these criticisms he would like to thank the authors for what had been a very interesting paper for all those concerned with survey work.

Mr. H. HENRY said that admirable though the paper was, it was not without flaws, and there were two points in particular to which he would like to draw attention. The first concerned the costs of interviews, as calculated in section 4.2, where there was evidence of a lack of acquaintance with the practical mechanics of field-work. A skilful and experienced investigator would often make an obviously "useless" first call (for example, where the required informant was a man and the call is made during working hours, so that the chances were about six to one against finding him at home) in order to make an appointment, through his wife, so that the second call might be productive. Time was thus spent, and costed against the first call, which was more properly a charge against the second, since any investigator who was concerned to increase the efficiency of the first call without reference to any subsequent calls would go about the operation quite differently.

To a lesser extent, a similar relationship was found between the second and third calls, and even between the third and fourth. In these circumstances, though he was not qualified to criticise the mathematics of Tables 7 to 9, he felt that these tables were based on a false premise, and were therefore highly misleading: calculations along more realistic lines would show much steeper gradients. None of the four organizations which took part in this experiment was happy about the conclusion, which contradicted all their experience, that the cost-per-interview was very much the same whether one stopped after the first call or went on to six calls. He, the speaker, suggested that the foregoing was the reason.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

His second point concerned the alleged "test" of the Politz-Simmons method. This method corrected the observed results, according to the probability that various strata of the population would be found at home, for the total population apart from what is called the "zero group"—that is, those people who were *never* at home, who could not be allowed for. Now if interviewing took place entirely during normal working hours, the zero group would contain about 85 per cent. of all men and about 60 per cent. of all women, and the final results would reflect only that small section of the population which was at home during the day. Nor was it true, as the authors suggested in Section 3.2, that the method might be expected to work reasonably well for daytime interviewing of housewives: the zero group of housewives by day would be about 24 per cent. of all housewives.

In this particular experiment, however, some of the first calls were made by day, and some during the evening: what we had, therefore, was a reflection of a population which was a cross between the daytime and the evening population, and the results were consequently, meaningless. It was hardly surprising that, in the 13 cases where the Politz-Simmons figures of Table 4 were significantly different at the 5 per cent. level from the R_T figures, the "corrected" figures were actually *farther* away, in no less than 6 cases, than the R_1 figures on which they were based.

Admittedly the authors pointed out that the Politz-Simmons method could hardly be expected to work in the circumstances of this experiment, and that the only real purpose in dealing with it was to see whether informants would be prepared to provide the necessary classificatory information. But in this case, as Mr. Politz himself pointed out when the paper was discussed with him recently why not leave it at that? Why have all the detailed calculations of Table 4, and Section 3 as a whole, merely to indicate that it was totally inappropriate to the circumstances, and that the experiment not only "did not give the method a fair trial" but in fact gave it no trial at all?

If he seemed to labour this point it was because, although the authors rendered lip-service to the inapplicability of the Politz-Simmons method to this case, references abounded throughout the paper in such words as "some indication of the extent to which it corrects for the bias of the R_1 sample", or "a slightly more erratic tendency in the Politz-Simmons method", or "the Politz-Simmons method produces rather poor results" or "badly biased downwards in the ... Politz-Simmons sample" or "has not appreciably improved the results". It would surely have been better not to include any mention of the Politz-Simmons method. It might be that there was some virtue in showing that inappropriate methods did not produce worth while results: if this were so, perhaps some day somebody would read a paper proving that penicillin did not cure juvenile delinquency.

Mr. GREGORY agreed with the authors that the absence of marked between-interviewer variability on this project, where the interviewers had no say in selecting the contacts, and its presence in the earlier study on quota sampling, suggested that interviewers differed widely in their interpretation of the quota instructions. For that reason, on quota samples at least, it was advisable to employ a large number of interviewers whose individual influence on the results would then be small.

A large number of interviewers meant small assignments. Some contended that investigators needed a good run before they could fully control the interview situation.

In this experiment the interviewers concerned had small assignments—30 interviews. Nevertheless an absence of variability was found, and therefore he drew the conclusion that small assignments did not necessarily involve risk.

Was it the same with the large assignments of say two or three hundred interviews? Was there a point where interviewer fatigue and conditioned expectation of reply began to affect the results?

He hoped that the next S.R.U. project would continue this study of interviewer variance. What, if any, was the difference in the work returned by a few investigators doing many interviews and many investigators doing only a few each?

The many problems of field-staff organization and training with their immediate impact on cost could not in his opinion be settled until this question had been answered.

Two points interested him in respect of any future use of the Politz-Simmons method. Firstly, on this survey a 30 per cent. success at first call must be considered low. If measures could be taken to ensure something nearer to—if not beyond—a 50 per cent. success at first call, he thought the Politz-Simmons would have a much fairer showing.

Secondly, it was apparent in the analysis of results, particularly those on employment and activities, that it would probably be a very dangerous method to use where the factors under consideration were correlated, either negatively or positively, with the "at home" attributes of the respondent.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Dr. DURANT said that the refusals in this experiment were about twice those usually experienced in a random survey. The authors were somewhat surprised and puzzled, and they invited explanations. He had corresponded with the authors on the subject, and before commenting on the correspondence there was some background which had to be filled in.

Firstly, he had no prior knowledge of his interviewers' performance, because the forms were sent by the interviewers direct to the London School of Economics. Secondly, their own interviewers were chosen at random, simply on the basis that they lived near to the area in which they were interviewing, and so it might be expected that there would be a considerable spread in their performance. Thirdly—and he mentioned these things because they had to be borne in mind when he went on to criticize his interviewers—their results had been included in the analysis of variance in the paper, and they did not seem to call for special comment. Again, their success rate was considerably higher than the success rate of the other organizations.

His explanation of the high rate of refusals was that in many cases they were not refusals at all. If they were refusals, they were refusals rather by the interviewer to follow up the person he was supposed to interview. As a confirmation of his hypothesis, he listed in a letter his interviewers in ascending order of their proportion of refusals, according to his own estimation, based upon what was known of their interviewing in other surveys. The authors then analysed their interviewers' performance, and found that the two lists coincided exactly. At the top there was a 90 per cent. success rate and at the bottom a success rate of something like 65 per cent. The top three interviewers had one refusal between them; the bottom three had seven refusals between them. This he accepted as a confirmation of his hypothesis and he wished to draw implications.

In his view the handling of a random sample survey by telling the interviewers right from the start, "You have to call back until you get your man", was an unhappy way of managing a survey. It took away the enthusiasm of the interviewer. It might mean, for instance, a long journey back to an area to make only one recall. To draw a second implication, concerning first calls, he would like to go back a little into the history of the work of this Research Unit. From study of the earliest work that it published and from one particular table in that paper he became convinced that some interviewers in some cases, on their first call, did not actually make the call; they just wrote down the word "Out". In this instance the top three interviewers had a success rate on their *first call* of 46 out of 90, or over 50 per cent.; the bottom three had a success on their first call of only 18 out of 86, or little more than 20 per cent. When he and those associated with him, therefore, had recently to design and manage a large random sample survey, they took care to counteract that danger. The result was that although the sample ran into more than ten thousand they had achieved a success rate on the first call which, when the results were published, would occasion surprise, and the total success rate would also occasion surprise. The way they did it was very simple. They made every interviewer bring back a souvenir showing that they had actually made a visit, and the souvenir was in the shape of the name of an informant. If nobody was in the house, they had to call next door. They had to get a name and write it down as evidence of a call having been made.

The significance of pushing up the success rate of the first call would become obvious when it was considered that as soon as it was in the neighbourhood of the 50 per cent. mark, then the second call and, *a fortiori*, the third and fourth calls, became more expensive than the first call. The interviewers had to travel over exactly the same ground and yet were necessarily dealing with a lower number of successful interviews. He would suggest that the work done so far on the respective costs of the first call and the second and third calls needed a revision based on realistic material. Those responsible for handling random samples should make interviewers produce evidence for every call they said they had made; otherwise, they were not doing their job properly.

The authors offered one conclusion which he thought was repugnant to common sense. They asked readers to believe that it cost more when the interviewers had to travel only a short distance than when they had to travel long distances, that it took them longer to go to houses which were close together than to houses which were further apart. The explanation he would offer of these somewhat surprising results was along the lines he had already suggested, that some of the recorded calls were not, in fact, made. Only if it were absolutely certain that all the calls had been made, were such figures realistic annd dependable.

He wished to join in the congratulations to the authors. Having participated in what led up to this paper, he knew what a difficult job they had handled.

Dr. FINNEY said that all who work on sampling would be much indebted to Mr. Durbin and Mr. Stuart for this stimulating paper. Those engaged in social surveys of this character perhaps forgot how widely so excellent a paper might be consulted by scientists who wished to employ sampling in entirely different fields of research; he wished to plead with the authors for one slight modification in their text before publication. His point was entirely one of terminology. The authors used the phrase "systematic selection" as though that were a particular type of random sampling.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Though he realized that this was a widespread usage in social surveys, he thought it liable to cause confusion and he hoped that the authors would either alter it or explain their meaning more fully.

Dr. Finney said that he was not for a moment suggesting that the systematic selection of names for the samples on which the present paper was based was in any way invalid, or even that the variances calculated from the sample were wrong. Nevertheless, the corresponding procedure could be seriously misleading in other circumstances. He had in mind particularly the use of area sampling in biology, agriculture or forestry, where it was common to encounter conditions under which even random selection of the first unit of the sample did not justify estimation of variance from differences between sampling units within one sample. It was of course well-known that periodic variation in the universe sampled, or other special patterns of serial correlation between potential sampling units, could lead to difficulties in the interpretation and especially in the assessment of variance for systematically selected samples.

Dr. Finney's fear was that some readers of this paper, unfamiliar with the particular circumstances of social survey sampling, might think to find in what Mr. Durbin and Mr. Stuart had said a justification for the general use of a systematically selected sample exactly as if all the theory of random sampling were directly applicable to it. He had often had difficulties in explaining to his biological colleagues the subtleties of the dependence of variance estimation on the procedure of sample selection. He hoped that the authors would not insist on making his task still harder in future by apparently adding the weight of their authority to the argument that any systematic sample is a set of sampling units that might have been obtained by random selection, and therefore can always be analysed accordingly: he was in fact sure that they intended nothing more than a verbal simplification on a point that was not important in their context. He therefore hoped that a footnote clarifying this matter might be added.

Mr. D. H. PICKARD said that he had handled a number of random samples by various means and he had been confused by the under-statements of younger people and the over-statements of older people. There was evidence of that in this instance. That very difficulty pursued them in their first experiment, where they had to adopt a re-weighting process to balance it out. Here they had a sample which had achieved interviews with everybody who *could* be interviewed, which should be able to tell them something about what they wanted to know. He thought that Mr. Gray had hit on the answer so far as the refusal rate problem was concerned. There were a number of other reasons why the refusal rate was high. The evidence within the survey itself showed, for example, a relatively wide difference in the refusal rate of different towns.

He did not altogether dispute the evidence of Dr. Durant's powers of extra sensory perception in forecasting results in advance, but he did not accept it entirely. They were told that refusals were invented. On at least one survey with which he had been associated they had carried out extensive recalls on refusals and found no evidence of it.

On the question of having a large number of investigators, this did give rise to difficulty in that one could give much less time to the training and briefing of the investigators. A new investigator taken on was by no means as valuable a member of the organization during her first week or ten days as she afterwards would become. The more investigators one had, the less one knew about them and the less contact one had with them.

The following contribution was received in writing:

Mr. A. S. C. EHRENBERG: I wish to comment on the purpose and the implications of the tables presented in this experimental study. Consider for example the biggest table, Table 4, and take for simplicity the columns R_1, R_3 and R_T only. For each column and each of the 32 questions, we are given a percentage, a certain standard error, and the sample size, i.e., almost 300 undigested values in all.

Now, most of the sample sizes are in fact a little above the averages of 300 for R_1, 700 for R_3 and 800 for R_T, those for subsidiary questions (e.g. the percentage of cigarette smokers out of all smokers) being considerably smaller. Again, standard errors mostly lie between about 1·5 and 3·0 for R_1 and R_T and between 0·4 and 1·0 for R_2; their size seems to be uncorrelated with the level of the percentages. Both sets of *detailed* values, having been used to obtain all possible significance stars and crosses, seem to be of no apparent further interest or value to the authors, let alone to the reader.

As regards the percentages themselves, that of low wage-earners is overestimated in R_1 by 11 per cent. (with respect to R_T), that of men is underestimated by 15 per cent. and those of the three "job" questions, 3, 4 and 5, are underestimated by 8 per cent. Five other questions are overestimated in R_1 by 1 to 3 per cent., and the remaining 22 questions are underestimated by about 1 to 7 per cent. The bias in R_3 varies generally from 0 to 1 per cent. and is almost invariably in the same direction as that of R_1. The biases seem uncorrelated with the level of the percentages,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

If the *purpose* of giving the detailed table is not apparent, three *implications* are. The first and least important is that the reader is left to do the authors' work. The second implication is that the authors have not attempted to understand the data themselves—what meaning, on the one hand, do they attach to the 32 R_T standard errors "printed for information only", and why, on the other hand, do they give the rank analysis (Table 5, etc.) which is *admittedly* quantitatively uninterpretable, instead of undertaking a straightforward analysis such as is sketched above?

The third, and almost intolerably important, implication is that the reporting of useless detail, liberally besprinkled with tests of significance, hides the absence of any useful analysis at all. Who can use the information that for some arbitrary, heterogeneous, collection of people the number of low wage-earners, for example, was overestimated by 11 per cent.?

Had we, however, been told that the bias is about 11 per cent. in the two London Boroughs, in the two large towns, and in the two small towns, we would have had a generalization of obvious—I hope—value. If the percentage of low wage-earners itself had varied, a further generalization would have been derived. If, on the other hand, *different* biases had been observed in the experimental units, our understanding of the behaviour of first-call biases would have been greatly improved, and further research stimulated.

The advantages of matching an experimental design with an experimental analysis are surely well enough attested to overcome any attraction left in the reporting of tables of still-born statistics. I think that Professor Kendall's opening quotation in his *Advanced Statistics* is not meant to be taken seriously.

The authors replied in writing as follows:

We must resist the suggestion, made by Dr. Nuttall and others, that in social survey research it is a necessarily sound principle to concentrate resources and avoid dispersal of effort. When the cost of observations is high, and large numbers of them are necessary, efficient experimentation may require not only the use of modern methods of design and analysis, but also the simultaneous investigation of a number of problems. Dispersal of effort is frequently worth while even if, as in our case, compromises have to be made between the requirements of the different problems. The test must be the aggregate value of the whole enquiry, and on this principle we stand firm even though we may have failed to apply it correctly in our particular enquiry.

We are also against the suggestion that one should always wait until one feels able to deliver some kind of "judgement" before publishing one's results. It is possible that the belief that such an obligation exists might account for the small proportion of the survey experience gained in this country which has been made available to the public. If any statement of principles is called for, we would say simply that a worker has a right to publish his findings and his inferences from them without assuming any judicial capacity.

Bearing these points in mind, we were surprised at some of the remarks made on our inclusion of the Politz-Simmons analysis. When we planned this inquiry there was no information in the literature about the practical performance of the method, and so far as we could discover, it had never been used in this country. With one exception, such survey workers as we consulted about it seemed to feel that it was not likely to be practicable. Granted that we wished to find out something about the performance of the method, we could have placed it at the top of our priority list and have arranged the experiment accordingly. However, this would have necessitated considerable sacrifices from the remaining parts of the enquiry. What we did was to place it at the bottom of our priority list and this necessitated sacrifices on the part of the Politz-Simmons method. Our attitude is that the information we obtained is not entirely without interest and cost virtually nothing, and that it is now up to others, as well as ourselves, to publish further accounts of the practicability and efficiency of the method.

Before going on to the rest of the discussion, perhaps we may deal with other points concerning the Politz-Simmons method. In reply to Mr. Nicholson, the reason why the sampling error of a P.S. estimate based on, say, 1,000 *calls* is a good deal larger than the sampling error of the mean of 1,000 *observations*, is not so much that the at-home probabilities are inaccurately estimated, as that in a sequence of trials of the 1,000 calls on the same 1,000 individuals, different sets of individuals would be found at home from trial to trial. Assuming that the conditions for the validity of the method are satisfied, an accurate knowledge of the at-home probabilities would not reduce the sampling error by very much; unless the correlation between the variable under study and the probability of being at home is near to unity, the sampling error of the P.S. estimate would remain substantially greater than that of the mean of 1,000 observations.

In reply to Mr. Gray, we used a seven-day weighting scheme, because with so many organisations taking part (and another planned to take part at the outset) interviews might have taken place on any day of the week: the result of this would have been, as he says, to overweight the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

"stay-at-homes" in the sample, but this can hardly account for the poor performance of the method. Possibly, as he says, informants give wrong information when asked to remember whether they were at home on recent occasions, but if this *is* so, a good deal of the information collected in routine market research is similarly suspect.

We must emphatically disagree with Mr. Gregory's warning against the use of the method when the subject of the enquiry is correlated with the probability of being found at home: it is precisely for these conditions that the method was designed, and it is easy to see that if there were no such correlation, the unweighted first call results are a perfectly good random sample in themselves, so that there is no recall problem at all.

Like Mr. Pickard, we agree with Mr. Gray's remarks concerning the high refusal rate, and in an operational survey we might well have followed Mr. Nicholson's suggestion regarding the weighting of refusals. We do not wholly understand Mr. Nicholson's remark concerning the subsampling of non-respondents: in the paper he refers to (Durbin, 1953) it was shown that unless the cost of all recalls were at least three times as high as the cost of the first call, the gain in efficiency from this method would be no more than 5 per cent., and is probably less—this is hardly worth bothering about.

Our substitution procedure for removed informants, criticized by Mr. Nicholson and Mr. Gray, was put forward for investigation, and we would not press its claims beyond saying that it is likely to be better than other substitution procedures commonly used. Our quota replacement experiment was made more with a view to reducing costs than because it was expected to lead to an improvement in accuracy.

We are grateful to Mr. Henry for his valuable point concerning the rationale of our least-squares analysis of costs per interview, and we shall certainly give this matter further thought. Dr. Durant's views on the carrying out of first calls are controversial; we think this is largely a matter of interviewer training.

In reply to Mr. Gray, our ratio of between- to within-town variance was based on some rough calculations made from a national survey with which one of us happened to be associated, but the example worked out in the paper is purely illustrative, and any other ratio may be substituted. It would be of great value to other workers designing surveys if the Social Survey could publish estimates of the components of error variance given by different types of sample.

Dr. Nuttall was mistaken in remarking on our exclusion of certain "exceptional" results. These results were in fact included in all the main calculations of the paper. However, in the case of Table 9 we gave the values obtained both by including and by excluding these results because we were interested to see how large the difference was and we thought the reader might also be interested.

Mr. Ehrenberg's remarks seem to us misconceived. We were not carrying out a factual survey, but a piece of methodological research, conducted on a composite experimental population. The magnitudes are bound to vary widely for other populations, and they are not particularly interesting for their own sakes.

Like Dr. Finney, we hope that no one will be misled by the general assumption that systematic samples from population street-lists may be treated as random samples. Perhaps it would be as well to use only the term "quasi-random" sampling for this procedure. We have inserted a footnote to this effect.

As Dr. Nuttall says, the questionnaire was a miscellaneous one; our purpose here was to include questions of any sort which were vulnerable to non-response bias. We agree with Mr. Gray that pre-coding of Record Sheets conceals information, and we will abandon the procedure in future. Mr. Pickard has answered Mr. Gregory's remarks concerning the employment of large numbers of interviewers.

We have found the discussion stimulating, and are grateful for the kind things said about the paper.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Ronald William Artingstall.
Thomas Bamford.
Patricia Maud Crouch.
Peter Anthony Daisley.
Alan Lindsay Davies.
P. Juraj Ecimovic.
Kenneth Limb.
Lord Morrison.
Hanna Nicola Nucho.
Charles Duncan Pomeroy.
Arthur Edward Preece.
Robert Whitaker Rutledge.
John Maurice Simmonds.
John Percy Lyon Truesdale.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Phenomenon of Labour Turnover

By H. Silcock

I

Apart from a few isolated studies, it is only within the last few years that labour turnover has been subjected to detailed investigation, with the result that a great deal more information, based on scientific observation, has been made available. Three studies in particular have made notable contributions. They are, first, the work undertaken by the Tavistock Institute of Human Relations at the Glacier Metal Company, reported by Rice *et al.* (1950, 1951, 1952), by Rice and Trist (1952), and by Hill (1951); secondly, a series of surveys carried out by a team from the University of Sheffield described by Greystoke *et al.* (1951); and thirdly the study in the Birmingham area carried out by Long (1951). In addition there are the more widespread but less detailed compilations of the Ministry of Labour, the British Institute of Management, and the Institute of Personnel Management.

Although variability is perhaps the most prominent characteristic of all reports; nevertheless the authors agree in many of their conclusions and a number of important characteristics recur time and time again. The stage appears to have been reached when we might pause to take stock and to look for some unifying pattern underlying the manifest variation.

The observed characteristics of labour wastage may be grouped under three heads. First, those which are strongly marked and appear as major phenomena requiring explanation. Secondly, minor characteristics which although quite generally observed, yet seem to be of much less importance. They can be regarded more as perturbations superimposed upon the major factors. The third group comprises those on which the evidence is fragmentary. Their importance is more difficult to assess and has certainly not been measured. Indeed it can scarcely be said that their existence has been substantiated by observation in the field despite constant reference to them by writers and speakers on the subject.

The first two groups may be conveniently summarized.

1. Strongly Marked Characteristics

(a) *The Annual Rate of Labour Turnover Exhibits Wide Variation between Different Firms*

This is seen most strikingly in the broad surveys of the British Institute of Management and the Institute of Personnel Management. A survey by the latter body, for example, covering the first half of 1948 shows annual rates varying between 5 per cent. and 143 per cent. The rate for part-time workers in one establishment in the plastics industry reached 287 per cent. In the Birmingham study rates varied from 5 per cent. to 95 per cent. per annum for males and from 17 per cent. to 133 per cent. for female turnover. This variation is observed among factories within the same industry and even persists between different establishments of the same company. Rice (1951) observed considerable variations between different departments of the same establishment and suggested that this measurable factor might be used for sociological investigation.

(b) *The Majority of Terminations of Employment are at the Request of the Employee*

In the Sheffield surveys the proportion of resignations fluctuated round 80 per cent. of all terminations and was not observed to fall below 75 per cent. The Birmingham study shows resignations were between 83 per cent. and 93 per cent. of all wastage. Rice *et al.* (1951) report proportions varying between 65 per cent. and 90 per cent. with the single exception of 1949 when it reached the low level of 46 per cent. This was a year of recession and redundancy for the Glacier Metal Co. and it seems surprising that in such circumstances the proportion could have been as high as it was.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This characteristic in particular would seem to depend on a high general level of employment for voluntary resignation usually implies at least the expectation of immediate re-engagement elsewhere.

(c) *The Amount of Wastage Decreases as Length of Service Increases*

This was observed and commented upon more than thirty years ago by Greenwood (1919) in his paper on "Problems of Industrial Organisation". The same characteristic has been observed in all subsequent studies of labour turnover. The *Journal of the Institute of Personnel Management* contains many references to this aspect of the problem; the B.I.M. points out that the majority of leavers are of short service; Long refers to "rapid fluctuations on the fringe of the labour force"; Rice refers to a period of "induction crisis"; Greystoke suggests a number of reasons to account for the observation, and most writers draw the conclusion that if a reduction of labour wastage is to be achieved attention must be concentrated on the first three months of service.

(d) *Wastage is Higher among Females than Males, and Higher among Married than Single Women*

Although this is generally true, a few exceptions will be found in the B.I.M. surveys though there is insufficient detail to determine whether the exceptions arise from offsetting by the operation of other factors. This characteristic is undoubtedly due, at least in part, to the large proportion of females who drop out of the industrial labour force at an early age to look after the home and bring up a family. It is possible that the female rates are exaggerated by the inclusion of women who leave their employment for domestic reasons only to restart later with the same firm when home circumstances permit them to do so. This suggestion is due to Greystoke.

(e) *Wastage Decreases as the Amount of Skill Exercised Increases*

Time and again personnel managers have drawn attention to the observation that labour turnover, in so far as it constitutes a problem, is almost confined to unskilled and semi-skilled grades. The lack of any precise definition of skill, and the difficulty of distinguishing between different degrees of skill, make this proposition less suceptible to adequate demonstration let alone proof. Some illustrative figures given by Long show skilled turnover rates below 1.1 per cent. per annum while those for semi-skilled and unskilled labour range from 24 per cent. upwards.

2. Less Prominent Characteristics

(f) *The Rate of Wastage Varies Directly with the General Level of Employment*

It is indeed only in times of full employment that the phenomenon attracts widespread attention and is treated as a problem. A survey of the general trend over the last 30 years is given by Long.

(g) *The Rate of Wastage Fluctuates Perceptibly with the Season of the Year*

January is a high month for voluntary terminations, while December is a low month: peaks in spring and autumn are separated by a trough in summer. Although this may be due, in part, to a seasonal drift of unskilled labour into industries offering higher earnings for short periods, the point cannot be determined without a study of the industrial history of individual persons. So far the available data are confined to the experience of firms and not persons.

(h) *The Rate of Wastage Tends to Decline as Age Increases*

It is difficult to separate this effect from length of service, for of course the two increase together. Nevertheless, Long adduces evidence to suggest that age may be regarded as a separate, though minor, factor.

The remaining characteristics are by no means clearly marked, nor can their importance be assessed at the present. First there is the economic force attracting labour from the lower to the higher paid occupations. A firm offering lower wages, or poorer prospects of promotion, or both, than can be obtained elsewhere must expect to lose labour. The effect has been observed to persist where the alternative employment offers higher earnings although wage rates remain

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

unchanged; that is to say, the opportunity to work overtime is the reason for the change of employment. The attraction of higher earnings (through overtime working) is probably greater for the lower paid than the higher paid worker, and since a lower rate is associated with a lesser skill this may account, at least in part, for the higher rate of turnover amongst unskilled grades.

The search for higher earnings will, in general, be confined to an area within reach of the worker's home, and hence the location of a factory must be expected to play a part in determining the level of turnover. In an area where there are many alternative employments the rate of turnover will be higher than in an area offering fewer opportunities for the worker to change his job.

Yet if these were major factors we should expect the firm providing higher earnings to retain the labour it attracts. The movement of labour should be, to some extent, a one-way traffic from lower to higher earning occupations. There is no evidence that this is so. The phenomenon of labour wastage is common to all firms investigated. It is evident that the economic theory, so often advanced and so rarely supported by quantitative observation, is insufficient to explain the observed facts. This is not to deny the validity of the economic argument. It is undoubtedly true. Yet its importance appears to have been over-emphasised in the past. Long and Bowyer (1953) did in fact find a positive correlation between earnings and the supply of labour, but the effect was quite small.

Size of firm, methods of selecting employees, and working conditions have also been put forward as factors influencing the level of turnover. The evidence on the first is conflicting and there is little indication that the effect, if it exists, is at all important. The last two must certainly play a part but there is little or no direct information as yet to help us to see these factors in their right perspective.

II

The general theory of labour turnover may be constructed by analogy with the life table if we regard a termination of employment as equivalent to a "death", and substitute "length of service" for "age". We can then draw up a table of corresponding quantities as in the following examples in which the first of each pair refers to the life table and the second to labour turnover.

Number of survivors to age x	l_x
Number remaining in employment at length of service x	$n\,F(x)$
Number of deaths between ages x and $x+1$	$d_x = l_x - l_{x+1}$
Number of terminations between length of service x and $x+1$	$n\{F(x) - F(x+1)\}$
Number living at ages x to $x+1$	$L_x = \int_0^1 l_{x+t}\,dt$
Number in employment with length of service between x and $x+1$	$n\int_x^{x+1} F(t)\,dt$
Central death-rate for age x	$m_x = d_x \mid L_x$
Specific rate of labour turnover for length of service x	$\dfrac{F(x) - F(x+1)}{\int_x^{x+1} F(t)\,dt}$
Complete expectation of life at $x = 0$	$\int_0^\infty l_t\,dt \mid l_0$
Average length of service in stable employee population	$\int_0^\infty F(t)\,dt$

The function $F(t)$, $\{0 \leqq F(t) \leqq 1,\ F(0) = 1\}$ may be called the survival function, and n stands for the number of entrants into employment in a given year. Corresponding to the "force of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

mortality" we have a "force of separation" measured by a rate of labour wastage which may be defined as

$$\varphi(t) = -\frac{d}{dt}\log F(t). \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The life table death-rate is the equivalent of the rate of labour turnover in a stable population, and these quantities are respectively the reciprocals of the last two expressions in the table above. A turnover rate defined in this way does not appear to be in general use. It may be that the nature of the industrial world makes it extremely unlikely that the stable state will ever be reached by any company and that those concerned with labour management have preferred a measurement which is related in a simpler way to the actual engagements and terminations recorded by them.

The "annual rate of labour turnover" in common use throughout industry follows the definition given by the British Institute of Management:

$$\text{Labour turnover} = \frac{100 \times \text{Number of leavers in a year}}{\text{Average number of persons employed during the year}}$$

This is analogous to the crude death-rate of vital statistics and may be regarded as a weighted average of specific turnover rates in which the weights are the number of survivors from successive annual groups of entrants. The rate for the year x (ignoring the factor 100) may be approximately equated to

$$\frac{\sum_t n_{x-t}\, F(t+\tfrac{1}{2})\, \varphi(t+\tfrac{1}{2})}{\sum_t n_{x-t}\, F(t+\tfrac{1}{2})}$$

Such an index is heavily influenced by the previous employment history of the firm. The numbers n_{x-t} may fluctuate over a wide range depending on the state of trade in general and on the changing fortunes of the individual firm in particular. There is nothing comparable with the fairly steady annual flow of new births in a national population. It is scarcely surprising that variation in the rate is one of the most prominent characteristics of the published statistics. What is more important is that the value of the rate in any year is likely to depend more upon past history than on the present state of labour relations. A comparison of crude turnover rates is likely to be more misleading than a comparison of crude death-rates. It is difficult to see what valid inferences may be drawn from a tabulation of the crude rates for a number of different establishments, yet such a table is a common feature of some recent surveys.

While it is clear that standardization would assist comparison there appear to be two difficulties in the way. In the first place it is not easy to suggest a standard set of weights that would be appropriate to a large number of firms differing widely in the composition of their employee population, though even unit weights would be an improvement on the present state of affairs. Secondly, the personnel records of few firms are designed so as to yield readily the information required to compute specific turnover rates.

Further consideration of the crude rate must be deferred until some theories concerning the nature of $\varphi(t)$ have been discussed.

III

The germ of a theory concerning the nature of the "force of separation" is put forward by Rice, Hill and Trist (1950). The authors say (p. 367):

"A method of representing labour turnover has been described which, in the case of two industrial firms, has been found to show a regularity which is characteristic of the firm concerned. In these two firms this regularity has occurred in spite of such major external events as mobilization; the reservation and de-reservation of various occupations; restriction of labour mobility, demobilization and reinstatement of servicemen; and the reorganization and reconversion of industry for peacetime production. Hence, it seems that the regularity described reflects the operation of basic social processes within the institutions", and conclude (p. 371):

"When . . . fluctuation(s) were accounted for there remained a level of turnover which was relatively constant for the institution in which it occurred".

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In a later paper Hill (1951) poses the question:

"In a persisting institution does the survival pattern of entrants exhibit the properties of a quasi-stationary process, i.e., does it remain throughout time at a roughly constant level and when forced temporarily to change does it return to this level?" After examination of his data he concludes:

"The results are therefore reconcilable with the theory that labour turnover is the resultant of a quasi-stationary process".

While I confess to some doubts concerning the precise nature of a quasi-stationary social process, I conclude nevertheless that a number of important properties are implied. The movement from entrant to leaver is regarded as continuous; the rate at which it proceeds is constant; this constant rate reflects and is determined by the characteristics of each individual firm; and finally, if the rate is disturbed by temporary extraneous forces it tends to revert to its former level when these forces cease to operate.

An essentially new element is the idea of a constant rate, which is independent of time and which is determined by the characteristics of the employing firm. If it is the force of separation which is constant it becomes a relatively simple matter to test the theory, though in fairness to Dr. Rice and his colleagues I must point out that what is being tested is only my interpretation of the theory.

Suppose then that

$$\varphi(t) = \alpha \quad \text{a constant} \qquad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

we have at once $F(t) = A\, e^{-\alpha t}$ and recalling that $F(0) = 1$ the survival function becomes the negative exponential

$$F(t) = e^{-\alpha t}. \qquad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

It will be observed that this function not only provides the constant rate demanded by Rice, it also satisfies the logical requirement that $F(t)$ shall be a steadily decreasing function. Furthermore, it agrees with the well-known observation, so adequately demonstrated by Rice, that the number of terminations steadily diminishes as length of service increases.

The distribution of leavers classified by length of service is simply

$$(t) = \alpha\, e^{-\alpha t}, \qquad t \geqq 0 \qquad . \quad . \quad . \quad . \quad . \quad (4)$$

where the reciprocal of the mean provides the maximum likelihood estimator of the constant α. This distribution has been fitted to Rice's data and the result is presented in Table 1. Since the data are grouped a small empirical correction has been made in estimating the mean.* One year is taken as the unit interval of time throughout. No appeal to any statistical test is required to see that the fit is a bad one. The notion that the force of separation is constant must be decisively rejected.

* On re-checking I find that, in the particular case where the class intervals (except the last) are of equal width, the maximum likelihood estimator of the parameter α in the grouped negative exponential distribution can be expressed as an explicit function of the observations.

Let the observations be grouped into k classes; let x_i be the lower limit of the ith class, $(i = 1, 2, \ldots, k;\ x_1 = 0)$ and let $x_{i+1} = x_i + h$, $(i = 1, 2, \ldots, k-1)$ leaving a final open interval $x \geqq x_k$. Let there be n_i observations in the class whose lower limit is x_i; $\Sigma\, n_i = n$. Then

$$L = \sum_{i=1}^{k=1} n_i \log \left\{ e^{-\alpha x_i} - e^{-\alpha(x_i+h)} \right\} - \alpha\, n_k\, x_k$$

and the solution of $\delta L \,/\, \delta \alpha = 0$ can be written, after after a little reduction, in the explicit form

$$\hat{\alpha} = \frac{1}{h} \log_e \frac{m+h}{m}$$

where

$$m = \sum_{i=1}^{k} n_i\, x_i \,/\, (n - n_k)$$

The use of this estimator leaves unaltered the conclusion stated above.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1

Glacier Metal Company and "X" Factory

Entrants of 1944–47

Distribution of Leavers assuming a Constant Force of Separation

	Number of Leavers			
	Glacier Metal Co.		*"X" Factory*	
Length of Service	*Observed*	*Expected*	*Observed*	*Expected*
Less than 3 months . . .	242	160·2	523	510·0
3 months	152	138·9	88	185·7
6 ,, ...	104	120·4	46	111·2
9 ,, ...	73	104·5	13	66·6
12 ,, ...	52	90·6	12	39·9
15 ,, ...	47	78·5	10	23·9
18 ,, ...	49	68·1	6	14·3
21 ,, ...	487	444·8	75	21·4
Number of entrants . .	1,206	1,206	773	773
Value of α	—	0·57	—	2·05

IV

The hypothesis advanced by Rice and Hill seems to place all the emphasis on the characteristics of the employing company. These include the type of labour contract, the rates of wages offered, the opportunities for earnings in excess of a normal week's wage, the working conditions and the social relations within the factory. No one will deny the importance of these factors, but with the exception of the last they are all factors on the side of demand for labour. They are what the employer has to offer. Nothing is said about factors on the side of supply. It seems unrealistic to suppose that the net effect of all these factors (even if they remain fixed) can be the same *for all employees*. The constant α should be regarded not as something determined by the firm alone, but as the result of an interaction between the characteristics of the firm and the characteristics of the individual employee. The satisfaction which the workman expects to find in his job will differ from one group of employees to another, and so the forces determining the rate of wastage will differ from one group to another. The hypothesis must be amended, and it will be postulated that there is not one value of α which describes the rate of wastage for all entrants, but a whole series of different values, $\alpha_1, \alpha_2, \ldots, \alpha_n$, each one characterizing a small homogeneous group. As before, the value of α which is appropriate to a particular group remains fixed and independent of time.

The whole of the previous analysis remains valid so long as it is applied separately to each homogeneous group with a distinct value of α. It is no longer valid when applied to a mixed batch of new entrants such as will usually occur in practice.

There is an obvious analogy with accident theory and indeed Adelstein (1952) has suggested that there may be common factors which render a man both liable to accidents and to change jobs readily. There does not appear to be any substantial evidence to show that the industrial nomad is liable to a high accident rate. It may be of course that evidence is not easy to obtain for a concurrence of "accident proneness" and readiness to change jobs would mean that the nomad will not usually be exposed to the risk of accident in any one employment for a sufficiently long time to become a subject of study. I suspect, however, that although the analogy may hold so far as the nature of the process is concerned, some of the underlying factors will be dissimilar. Accordingly while I follow accident theory in supposing that the force of separation, measured by α, has a gamma distribution I do not postulate that this results from the operation of identical factors.

The hypothesis therefore becomes: (1) The interaction between the characteristics of the employing company and the characteristics of the individual employee results in a constant force of separation measured by the quantity α. (2) The quantity α varies from one employee to another with the probability distribution

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$g(\alpha) = \frac{\lambda^s}{\Gamma(s)} e^{-\lambda\alpha} \alpha^{s-1}, \lambda > 0, s > 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where λ and s are variable parameters.

It will be observed that whereas accident proneness, if it exists, would seem to be a characteristic of the individual, the rate of wastage depends on both employer and employee and might be expected to change as the individual moves from one job to the next.

The distribution of leavers by length of service is given by

$$f(t) = \int_0^\infty \alpha e^{-\alpha t} g(\alpha)\, d\alpha$$

$$= \frac{s}{\lambda} \left(\frac{\lambda}{\lambda + t}\right)^{s+1}, \quad t \geqq 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

with mean $= \lambda/(s-1)$, and variance $\frac{\lambda^2 s}{(s-1)^2 (s-2)}$.

The survival function becomes

$$F(t) = 1 - \int_0^t f(x)\, dx = \left(\frac{\lambda}{\lambda + t}\right)^s \quad . \quad . \quad . \quad . \quad (7)$$

and the rate of wastage is

$$\varphi(t) = -\frac{d}{dt} \log F(t) = \frac{s}{\lambda + t} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

On the original hypothesis the rate of wastage was a constant α; it is now a decreasing function of time, falling steadily as length of service increases. This is because entrants with a high value of α, comprising largely the drifters of the industrial world, the misfits and the dissatisfied, will tend to leave, both by resignation and dismissal, more quickly than the remainder of the entrants. Those who remain in employment gradually become "self-selected" in the sense that the proportion with low values of α increases with length of service and in consequence the rate of wastage steadily diminishes.

The effect of a change in the parameters is more clearly seen in the wastage rate than in the survival function. An increase in s is accompanied by a proportionate increase in the wastage rate for all lengths of service. As λ increases the rate of wastage decreases, but the effect is chiefly marked at the early periods of service and becomes progressively smaller as length of service increases. The parameter λ can be regarded as introducing a time-lead: if it is increased by unity the rate of wastage formerly applicable to length of service t becomes that for $t - 1$, and so the lower rate is attained a year earlier. Since for large t the rate is decreasing very slowly, the effect of a time-lead is correspondingly small for the old hands.

The problem of estimating the parameters λ and s from a distribution of leavers is a little troublesome. Using the principle of maximum likelihood, and writing L for the logarithm of the likelihood, we have for ungrouped data

$$\frac{\partial L}{\partial s} = \frac{n}{s} - \sum_{i=1}^{n} \log (1 + t_i/\lambda)$$

giving

$$s = \frac{n}{\sum_i \log (1 + t_i/\lambda)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

as an estimator of s, where the logarithms are to base e. For λ we have

$$\frac{\partial L}{\partial \lambda} = \frac{1}{\lambda} \left\{(s+1) \sum_{i=1}^{n} \frac{t_i}{\lambda + t_i} - n\right\}$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

which, on inserting the expression for s from (9) and equating to zero requires a value λ which satisfies

$$\frac{1}{\sum_i t_i/(\lambda + t_i)} - \frac{1}{\sum_i \log (1 + t_i/\lambda)} = \frac{1}{n}. \quad . \quad . \quad . \quad . \quad (10)$$

An approximate solution to this equation can be found by inverse interpolation. The quantities involved in its solution also provide the value of s.

However, the available data are grouped by length of service, usually in 3-monthly intervals, and since the density function decreases steadily as t increases a correction for grouping becomes necessary. The correction, empirically determined, proved to be quite small. Save for one exceptional case it consisted of deductions averaging 0·0312 from $\Sigma \log (1 + t/\lambda)$ and 0·0166 from $\Sigma t/(\lambda + t)$. The exception (referred to later as "X" factory) was characterized by an unusually small value of λ (0·06) producing a high initial rate of wastage. The fit in this case should be regarded as no more than a first approximation.

The distribution given by (6) has been fitted to a variety of data. For reasons of space only a selection of the results can be presented here. Table 2 shows the fit for data published by Dr. Rice and his colleagues and Table 3 for data given by Long (1951).

There is an inevitable element of danger in using data collected by other workers for the purpose of testing some hypothesis. The data may be subject to just those extraneous forces which the hypothesis fails to take into account. To overcome this difficulty further data were compiled.

For these new data I am indebted to Messrs. J. Bibby & Sons, Ltd., who generously gave permission for the material to be extracted from their personnel records. Most of the data hitherto published relate to engineering and allied industries. These data offer a complete contrast, for the Company is primarily engaged in the manufacture of animal feeding stuffs and soap. The figures relate to their main factory in the Merseyside area.

In considering the data there is one perceptible extraneous factor which must be taken into account. In one department the work is subject to seasonal variations in output, and an effort has been made to exclude the operation of the seasonal factor by confining the investigation to employees who leave and have to be replaced. The working solution adopted was to exclude persons declared redundant. The record was arranged in four sections: those who entered into the service of the Company in 1950, and those who entered during 1951, each group being separated according to sex. The fit to these data is presented in Tables 4 and 5.

TABLE 2

Glacier Metal Company and "X" Factory: Entrants of 1944–47

Distribution of Leavers by Length of Service

	Number of Leavers			
	Glacier Metal Co.		*"X" Factory*	
Length of Service	*Observed*	*Expected*	*Observed*	*Expected*
Under 3 months . . .	242	242·0	523	524·9
3 months	152	150·3	88	83·3
6 ,, ...	104	103·8	46	37·1
9 ,, ...	73	76·5	13	21·7
12 ,, ...	52	59·2	12	14·4
15 ,, ...	47	47·4	10	10·4
18 ,, ...	49	38·8	6	7·9
21 ,, ...	487	488·0	75	73·3
Entrants	1,206	1,206·0	773	773·0
$\hat{\lambda}$		0·664		0·060
$\hat{s}$		0·701		0·692
χ^2		3·741		6·806
d.f.		5		5
P		0·58		0·24

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In considering the results it should be remembered that the data are from three separate investigations and cover widely different industries situated in the London area, the Midlands, and the North of England. On the χ^2 test for goodness of fit four of the eight results yield a probability exceeding 0·2 and seven exceed 0·05. There is one bad fit. This is for Long's data (females). Apart from a comment by Long (1952, on p. 35) that "female turnover fluctuated particularly widely in Firm D" I have no information which would permit a further examination of this particular case.

In view of the variety of sources it is remarkable that the estimated values of the parameter s fall within such a narrow range. Six out of the eight results are in the interval from 0·5 to 1·0. The only theoretical restriction is that the quantity must be positive yet no value has been found below 0·3 or above 1·5. There is much less similarity in the values of λ, and as this parameter appears in the form $1/\lambda$ in the survival function the effect of small values is enhanced.

TABLE 3

Long's Data for Factories D.1 and D.3

Distribution of Leavers by Length of Service

	Number of Leavers			
	Males		*Females*	
Length of Service	*Observed*	*Expected*	*Observed*	*Expected*
Under 1 month	35	35·6	42	38·0
1 month	33	30·1	36	49·7
3 months	15	19·4	59	42·7
6 ,,	19	16·8	35	42·2
12 ,,	47	47·1	86	85·4
Entrants	149	149·0	258	258·0
$\hat{\lambda}$		0·119	0·460	
$\hat{s}$		0·513	0·956	
χ^2		1·575	11·651	
d.f.		2	2	
P		0·46	0·003	

TABLE 4

J. Bibby & Sons, Ltd.: Entrants of 1950

Distribution of Leavers by Length of Service

	Number of Leavers			
	Males		*Females*	
Length of Service	*Observed*	*Expected*	*Observed*	*Expected*
Under 3 months	182	195·4	25	30·7
3 months	103	87·5	26	22·3
6 ,,	60	51·8	22	16·8
9 ,,	29	35·0	13	13·0
12 ,,	31	25·6	15	10·4
15 ,,	23	19·7	7	8·4
18 ,,	10	15·8	5	7·0
21 ,,	8	13·0	1	5·8
24 ,,	7	10·9	4	4·9
27 ,,	176	174·3	51	49·7
Entrants	629	629·0	169	169·0
$\hat{\lambda}$		0·280	1·660	
$\hat{s}$		0·583	1·429	
χ^2		13·148	9·191	
d.f.		7	6	
P		0·07	0·16	

CC-0.In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5

J. Bibby & Sons, Ltd.: Entrants of 1951

Distribution of Leavers by Length of Service

Length of Service	*Number of Leavers*			
	Males		*Females*	
	Observed	*Expected*	*Observed*	*Expected*
Under 3 months	147	147·1	38	41·2
3 months	54	58·7	29	22·5
6 ,,	47	34·5	15	14·6
9 ,,	21	23·6	9	10·4
12 ,,	12	17·6	5	7·8
15 ,,	237	236·5	77	76·5
Entrants	518	518·0	173	173·0
$\hat{\lambda}$		0·170		0·448
$\hat{s}$		0·369		0·613
χ^2		6·974		3·334
d.f.		3		3
P		0·07		0·34

On the assumption of a steady annual intake of n employees the ultimate size of the employee population would be $n\int_0^\infty F(t)\,dt$. This integral converges only for $s > 1$ when it has the value $n\lambda/(s-1)$. The annual turnover rate in this stable population would be $(s-1)/\lambda$.

The values found for λ and s average about 0·5 and 0·7 respectively. Inserting these values and assuming for the purpose of illustration that 40 years is the upper limit for length of service the ultimate size of the employee population would be about $4{\cdot}56n$, with an annual turnover of 22 per cent. Such calculations, however, are only of theoretical interest since the attainment of a stable population seems, from the economic point of view, a rather remote possibility.

The operating conditions of individual firms vary too much to make it possible to suggest any particular combination of λ and s as producing a satisfactory rate of wastage. Two possible criteria, however, might be borne in mind. The distribution of α among an entrant group, given by (5) has a mean s/λ and variance s/λ^2 so that the coefficient of variation is $1/\sqrt{s}$. The rate of wastage (8) may be written:

$$\frac{s}{\lambda}\left(1+\frac{t}{\lambda}\right)^{-1} = \bar{\alpha}\left(1+\frac{t}{\lambda}\right)^{-1} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and it is obvious that this varies directly with the mean value of α. If selection procedure is aimed at producing a low rate of wastage at all lengths of service then $\bar{\alpha}$ should be small. Secondly if homogeneity so far as the force of separation is concerned is regarded as desirable in an entrant group then a low value of $\bar{\alpha}$ must be coupled with a small coefficient of variation. These two conditions require (i) s should be large so that $1/\sqrt{s}$ is small, and (ii) λ should be large compared with s, so that s/λ is small. The estimated values found for the parameters exhibit the reverse of these conditions.

V

It is frequently held that the crude annual rate of labour turnover (as defined in Section II) may be used as one of a number of indices of the level of morale amongst the employee population. While it may be true that conditions of work leading to low morale may be accompanied by a high rate of wastage the converse is not necessarily true. It will be recalled that the crude rate is (approximately) a weighted average of the quantities $\varphi(t+\frac{1}{2})$ in which the weights are the "survivors" from each annual group of entrants. Since $\varphi(t)$ appears from the previous analysis to be a decreasing function of t the larger terms are those for the early years of service and if they are

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

associated with large weights a high crude rate will result. These are precisely the conditions which are present during a rapid expansion of the labour force. Again a high crude rate may result from a large value of $\bar{\alpha}$ due to a defective system of employee selection. In neither case is there any necessary implication of low morale among the workers.

It has been held that differences in the crude rate of turnover reflect differences in the characteristics of the employing firms and this leads to the suggestion that high turnover calls for changes in management policy. This again is not necessarily true. The crude rate may give a misleading picture of a complex situation. Furthermore, if the rate α depends on an interaction between employer and employee, a mere change in the characteristics of the firm may reduce the rate for some types of employees only to increase it for others. It seems clear that more attention should be given to selecting those employees whose characteristics interact with those of the firm so as to produce small values of α.

The difficulties of interpreting the crude rate are such that it would probably be better to abandon it altogether and to seek an alternative measure of the employer's power to retain labour. I am indebted to Professor D. G. Champernowne for the suggestion that the median of the distribution of leavers might provide the required alternative. It represents the time required for a batch of entrants to be reduced, by terminations, to one-half of its original size. It has the merits of being easily understood, of being simple to compute, and of proving a ready means of comparison between different firms as well as between different entrant groups. The median of the distribution given by (6) is $\lambda\,(2^{\frac{1}{s}} - 1)$ and always exists, whereas neither the mean of the distribution nor the equivalent of the life table death rate exists save where $s > 1$.

The medians of the distributions given in tables 2 – 5 are:—

Glacier Metal Co.	13·4 months
"X" Factory	1·2 ,,
Long's data, male	4·1 ,,
,, ,, , female	5·9 ,,
J. Bibby & Sons Ltd., 1950, male	7·7 ,,
,, ,, ,, , female	12·5 ,,
,, ,, 1951, male	11·3 ,,
,, ,, ,, , female	11·3 ,,

VI

It remains to see how far the preceding theory is consistent with, or "explains", the general observations which were summarized in Section I. The wide variation in computed rates of "labour turnover" has already been seen to be a likely result of the variety of different influences which affect this crude indicator. It follows that comparisons of the rate between different firms may be very misleading, and it seems scarcely necessary to add that executive action based upon such comparisons may entirely fail to achieve the intended result.

The theory is consistent with the observation that the amount of wastage diminishes as length of service increases and shows that this is true not only of the absolute amount but also of the rate of wastage.

The observation that labour turnover varies with the general level of employment is not directly explained, but it may be shown that it is consistent with the theory. The available data all refer to the post-war period of full employment, and any statements made about other periods must to some extent be a matter of speculation. Theory suggests that labour turnover is a continuous phenomenon, present both in times of full employment and of under-employment: observation suggests that the pace is quickened as the level of employment rises, so that eventually it comes to be regarded as a problem. When unemployment is high there is a large reservoir of potential labour and the number of applicants for each vacancy is increased. Employment officers, given a wider choice of candidates, are able to make a better selection of recruits. Among those engaged there will be fewer misfits and fewer of the industrial nomads. In terms of the theory the entrant group will have a smaller average value of α and will also be more homogeneous than can be expected in times of full employment. In consequence, the rate of wastage for the entrant group

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

will be reduced. Secondly, in times of unemployment the size of the entrant group will also be small since fewer workers are being replaced. Thirdly the process of industrial contraction will have had regard, to some extent at least, to the principle of "last-in, first out". The effect of these factors on the conventional rate of labour turnover is twofold: (i) there is a reduction in the large values of $\varphi(t)$ associated with groups in the early months of service; (ii) there is a change in the weights so that the larger weights tend to be associated with the long service groups characterized by small values of $\varphi(t)$. These effects are cumulative and operate to reduce the level of labour turnover in conditions of under-employment.

When the level of employment begins to rise the first effect is an increase in the size of entrant groups so that larger weights begin to be associated with the initial large values of $\varphi(t)$. Later, when labour becomes more scarce and the choice of recruits more limited, the entrant group tends to become more heterogeneous and $\varphi(t)$ tends to increase with each successive batch of entrants.

The fact that in full employment the majority of terminations are at the employees' request may simply reflect the economic climate which makes it profitable for the employer to retain the labour he recruits. Of the remaining characteristics noted in Section I only Long's suggestion that age may be regarded as a distinct factor seems to be inconsistent with the analysis. The lower wastage rates for men than for women, and for skilled workers compared with the semi-skilled and unskilled must reflect individual and group characteristics which interact with those of the firm to produce the resultant force α. To suggest what they are and how they might be recognized would be to cross the boundary beyond which it is unsafe to stray without the collaboration of colleagues from industrial psychology and sociology.

I wish to express my thanks to Dr. A. K. Rice of the Tavistock Institute of Human Relations and to Dr. Joyce R. Long of the University of Birmingham for permission to use data collected by them, and to acknowledge my indebtedness to Messrs. J. Bibby & Sons, Ltd., for their generous co-operation in the extraction of data from their personnel records and for permission to publish the data so obtained.

References

ADELSTEIN, A. M. (1952), "Accident proneness: A criticism of the concept based upon an analysis of shunters' accidents", *J. R. Statist. Soc.*, A, **115**, 354–400.

BEHREND, H. (1953), "Absence and labour turnover in a changing economic climate", *Occupational Psychology*, **27**, 69–79.

GREENWOOD, M. (1919), "Problems of industrial organisation", *J.R. Statist. Soc.*, **82**, 186–209.

GREYSTOKE, J. R., *et al.* (1951), "Surveying labour turnover in the Sheffield region", *Yorks. Bull. of Econ. and Soc. Research*, **3**, 83–101.

HILL, J. M. M. (1951), "A consideration of labour turnover as the resultant of a quasi-stationary process", *Human Relations*, **4**, 255–264.

LONG, J. R. (1951), "Labour turnover under full employment", Birmingham, the University, Research Board. Faculty of Commerce and Social Science.

—— & BOWYER, I. (1953), "The influence of earnings on the mobility of labour", *Yorks. Bull. of Econ. and Soc. Research*, **5**, 81–87.

RICE, A. K., HILL, J. M. M., & TRIST, E. L. (1950), "The representation of labour turnover as a social process", *Human Relations*, **3**, 349–372.

RICE, A. K. (1951), "An examination of the boundaries of part-institutions", *Human Relations*, **4**, 393.

—— (1952), "The relative importance of sub-institutions as illustrated by departmental labour turnover", *Human Relations*, **5**, 83–90.

—— & TRIST, E. L. (1952), "Institutional and sub-institutional determinants of change in labour turnover." *Human Relations*, **5**, 347–371.

(Author not stated) (1948), "Labour turnover", *J. Inst. Personnel Management*, **30**, 232–236.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Relations Between Chained Indexes of Input, Gross Output and Net Output

By P. H. Karmel

The investigations which follow stem from some rather odd results obtained by a colleague* in the calculation of an index of production for a sector of Australian industry. The index was calculated by a chaining process. For some years, the index of gross output was higher than that for input, but the index of net output was lower than that for gross output. This perverse result requires some explanation.

1. Theoretical

1.1. We define

$$I_{01} = \frac{\Sigma p_0 q_1}{\Sigma p_0 q_0}$$

and

$$G_{01} = \frac{\Sigma P_0 Q_1}{\Sigma P_0 Q_0}$$

as indexes of input and gross output of an industrial sector, where the P's and Q's are prices and quantities of outputs and the p's and q's are prices and quantities of inputs and the comparison is between periods 0 and 1. The formula for net output is defined by†:—

$$N_{01} = \frac{\Sigma P_0 Q_1 - \Sigma p_0 q_1}{\Sigma P_0 Q_0 - \Sigma p_0 q_0}$$

This can be written

$$N_{01} = \frac{G_{01}\Sigma P_0 Q_0 - I_{01}\Sigma p_0 q_0}{\Sigma P_0 Q_0 - \Sigma p_0 q_0}$$

We put

$$\frac{\Sigma p_0 q_0}{\Sigma P_0 Q_0} = k_0 \qquad \frac{I_{01}}{G_{01}} = m_{01} \qquad \frac{N_{01}}{G_{01}} = r_{01}.$$

Then k_0 is the ratio of the value of input to the value of output in the period 0, m_{01} measures the movement in input quantum relatively to that in gross output quantum and r_{01} measures the movement in net output quantum relatively to that in gross output quantum as between period 0 and 1. Hence :

$$r_{01} = \frac{1 - k_0 m_{01}}{1 - k_0}.$$

1.2. It follows that since $k_0 < 1$

$$\begin{aligned} r_{01} &> 1 > m_{01} \\ \text{or } r_{01} &= 1 = m_{01} \\ \text{or } r_{01} &< 1 < m_{01} \end{aligned}$$

i.e.,

$$\begin{aligned} N_{01} &> G_{01} > I_{01} \\ \text{or } N_{01} &= G_{01} = I_{01} \\ \text{or } N_{01} &< G_{01} < I_{01} \end{aligned}$$

* Mr. R. R. Hirst, of the Department of Economics, University of Adelaide.

† This formula was originally suggested by Roland Wilson in a paper entitled "Prices, Quantities and Values" read to the Victorian Branch of the Economic Society of Australia and New Zealand, September, 1937, and published in pamphlet form. It was subsequently developed by S. S. Fabricant in "The Output of Manufacturing Industries, 1899-1937", New York, National Bureau of Economic Research, 1940 and by R. C. Geary in "The Concept of the Net Volume of Output with Special Reference to Irish Data", *J. R. Statist. Soc.*, **107**, 1944. It is usually known as the "Geary formula".

CC-0.In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No other orderings are possible. These orderings are what one would expect intuitively. Indeed any other orderings can be said to be mutually inconsistent, e.g., if we had $N_{01} < I_{01} < G_{01}$, this would mean that although input rose less (or fell more) than output, net output rose even less (or fell even more) than gross output.

1.3 However, when indexes such as I_{01}, G_{01} and N_{01} are chained inconsistent orderings can arise. Consider a comparison involving two links. We should have

$$r_{01} = \frac{1 - k_0 m_{01}}{1 - k_0}$$

and

$$r_{12} = \frac{1 - k_1 m_{12}}{1 - k_1}$$

We define

$$p_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}$$

and

$$P_{01} = \frac{\Sigma P_1 Q_1}{\Sigma P_0 Q_1}$$

as indexes of input and output prices respectively; and

$$t_{01} = \frac{p_{01}}{P_{01}},$$

where t_{01} measures the movement in input prices relatively to that in output prices as between periods 0 and 1. Hence:

$$k_1 = k_0 m_{01} t_{01}$$

so that:

$$r_{01} r_{12} = \frac{1 - k_0 m_{01}}{1 - k_0} \cdot \frac{1 - k_0 m_{01} t_{01} m_{12}}{1 - k_0 m_{01} t_{01}}$$

1.4. We have to inquire whether any orderings of the chained indexes $N_{01} N_{12}$, $G_{01} G_{12}$ and $I_{01} I_{12}$ can occur other than:

$$N_{01} N_{12} > G_{01} G_{12} > I_{01} I_{12}$$
$$N_{01} N_{12} = G_{01} G_{12} = I_{01} I_{12}$$
$$N_{01} N_{12} < G_{01} G_{12} < I_{01} I_{12}$$

i.e., whether any orderings of $r_{01} r_{12}$, 1 and $m_{01} m_{02}$ can occur other than:

$$r_{01} r_{12} > 1 > m_{01} m_{12}$$
$$r_{01} r_{12} = 1 = m_{01} m_{12}$$
$$r_{01} r_{12} < 1 < m_{01} m_{12}$$

1.5. In reference to the formula for $r_{01} r_{12}$ we should note that $k_0 m_{01} t_{01} < 1$ since $k_0 m_{01} t_{01} = \kappa_1$ In addition, in practice, $k_{01} m_{01} < 1$, since

$$k_0 m_{01} = \frac{\Sigma p_0 q_1}{\Sigma P_0 Q_1}.$$

If $k_0 m_{01} > 1$ the index of net output would be negative and the result meaningless. So long as we are concerned with meaningful results we can take $k_0 m_{01} < 1$

If $m_{01} = 1$, $r_{01} r_{12}$ reduces to

$$\frac{1 - k_0 t_{01} m_{12}}{1 - k_0 t_{01}} = r_{12}$$

and if $t_{01} = 1$, it reduces to

$$\frac{1 - k_0 m_{01} m_{12}}{1 - k_0}$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In both cases consistent orderings must occur. This must happen whenever the indexes of input and gross output quanta have moved together or the indexes of input and gross output prices have moved together. Consistent orderings must also occur wherever both m_{01} and $m_{12} > 1$ or both m_{01} and $m_{12} < 1$. However, in other circumstances inconsistent orderings can, but not necessarily must, arise. This can be seen as follows.

1.6. We write

$$r_{01}\, r_{12} = \frac{1 - k_0\, m_{01}}{(1 - k_0)\,(1 - k_0\, m_{01}\, t_{01})} - \frac{(1 - k_0\, m_{01})\, k_0\, m_{01}\, t_{01}}{(1 - k_0)\,(1 - k_0\, m_{01}\, t_{01})}\, m_{12}$$

Then $r_{01}\, r_{12}$ is a linear function in m_{12}, with parameters k_0, m_{01}, t_{01}. The intercept of $r_{01}\, r_{12}$ on the Y axis is positive and its slope is negative. Now draw on the same diagram $r_{01}\, r_{12}$ and $m_{01}\, m_{12}$ as

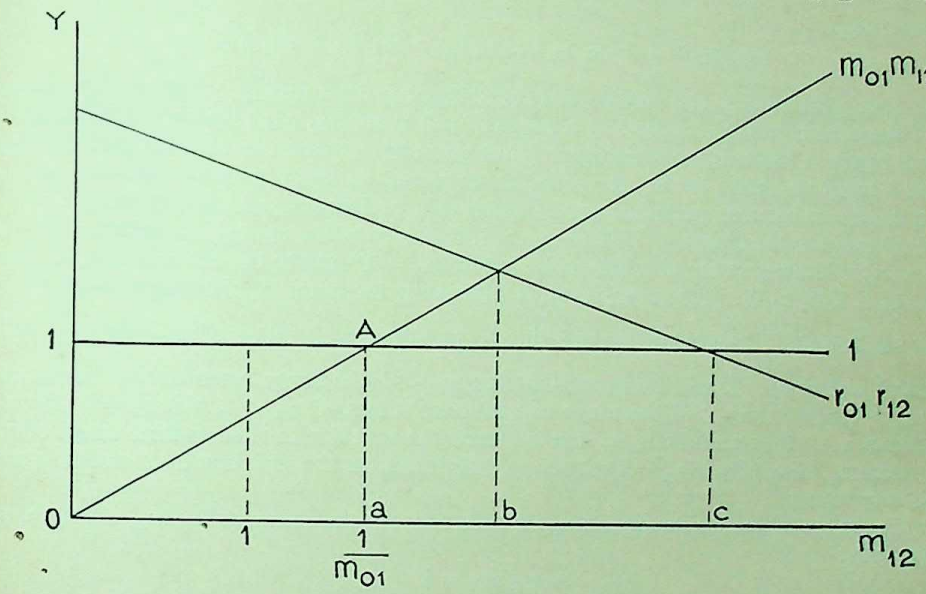


FIG. 1

functions of m_{12} and an abscissa at unity. The relative position of the lines depends on whether $m_{01} \gtreqless 1$ and $t_{01} \gtreqless 1$. First, take the case of $m_{01} < 1$. Then the slope of $m_{01}\, m_{12}$ will be less than 45°. Let $m_{01}\, m_{12}$ intersect the unit line in A, i.e., where

$$m_{12} = \frac{1}{m_{01}} > 1$$

For $m_{01} < 1$, $r_{01}\, r_{12}$ must intersect the unit line to the right of $m_{12} = 1$* and it must leave the Y axis above the unit line.† If $t_{01} < 1$, it will intersect the unit line to the right of A.‡ This is the

* For $m_{12} = 1$, $r_{01}\, r_{12} = \frac{1 - k_0\, m_{01}}{1 - k_0}$ and hence at $m_{12} = 1$, $r_{01}\, r_{12} \gtreqless 1$ according as $m_{01} \lesseqgtr 1$

† The intercept of $r_{01}\, r_{12}$ on Y will be $\gtreqless 1$ according as

$$\frac{1 - k_0\, m_{01}}{(1 - k_0)\,(1 - k_0\, m_{01}\, t_{01})} \gtreqless 1$$

i.e., according as $1 - m_{01} \gtreqless - m_{01}\, t_{01}\,(1 - k_0)$.

For $m_{01} < 1$, the top inequality must hold. Since $k_0\, m_{01} < 1$, the bottom inequality can hold, only if $m_{01} > 1$ and $t_{01} < 1$ and then only if t_{01} is sufficiently small.

‡ For $m_{12} = \frac{1}{m_{01}}$, $r_{01}\, r_{12} = \frac{1 - k_0\, m_{01}}{1 - k_0} \cdot \frac{1 - k_0\, t_{01}}{1 - k_0\, m_{01}\, t_{01}}$ and $r_{01}\, r_{12} \gtreqless 1$ according as $(1 - t_{01})(1 - m_{01}) \gtreqless 0$

Hence at $m_{12} = \frac{1}{m_{01}}$, $r_{01}\, r_{12} = 1$ if either $t_{01} = 1$ or $m_{01} = 1$ and $r_{01}\, r_{12} \gtreqless 1$ according as both t_{01} and m_{01} lie on the same side of or on different sides of unity.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

case shown in the diagram. If $t_{01} > 1$, $r_{01} r_{12}$ will intersect the unit line to the left of A.

Now consider the above diagram which depicts the case of $m_{01} < 1$ and $t_{01} < 1$. It is plain that for $0 < m_{12} < a$, the ordering will be

$$r_{01} r_{12} > 1 > m_{01} m_{12}, \text{ i.e., } N_{01} N_{12} > G_{01} G_{12} > I_{01} I_{12},$$

for $a < m_{12} < b$

$$r_{01} r_{12} > m_{01} m_{12} > 1, \text{ i.e., } N_{01} N_{12} > I_{01} I_{12} > G_{01} G_{12},$$

for $b < m_{12} < c$

$$m_{01} m_{12} > r_{01} r_{12} > 1, \text{ i.e., } I_{01} I_{12} > N_{01} N_{12} > G_{01} G_{12},$$

and for $c < m_{12}$

$$m_{01} m_{12} > 1 > r_{01} r_{12}, \text{ i.e., } I_{01} I_{12} > G_{01} G_{12} > N_{01} N_{12}.$$

Of these four possibilities, the middle two orderings are inconsistent. Accordingly given the values of the parameters k_{01}, m_{01} and t_{01} a range of values for m_{12} lying between a and c will exist which will result in inconsistent orderings. Thus given the situation as between periods 0 and 1, there will a range of values for m_{12} (i.e., for the movement in input quantum relatively to that in output quantum as between periods 1 and 2) which will produce inconsistent orderings.

Turning again to the diagram. When $m_{01} > 1$, the slope of the $m_{01} m_{12}$ line becomes more than 45° and $r_{01} r_{12}$ will intersect the unit line to the left of $m_{12} = 1$* and to the left of A if $t_{01} < 1$ and to the right of A if $t_{01} > 1$‡. However, if m_{01} is sufficiently large and t_{01} sufficiently small the $r_{01} r_{12}$ line may start on the Y axis below the unit line.† In this case all values of m_{01} below $\frac{1}{m_{01}}$ will give inconsistent orderings. It will be noted that for $m_{01} < 1$ the range extends over values of m_{12} where $m_{12} > 1$, and for $m_{01} > 1$ the range extends over values of $m_{12} < 1$. If $m_{01} = 1$, the $m_{01} m_{12}$ line becomes a 45° line, and the $r_{01} r_{12}$ line intersects the unit line in A so that no range of inconsistency occurs. Similarly if $t_{01} = 1$, the $r_{01} r_{12}$ line intersects the unit line in A and no range of inconsistency occurs.‡

1.7. The range of inconsistency for m_{12} extends between the solutions for m_{12} of the following two equations:

$$m_{01} m_{12} = 1$$

and

$$r_{01} r_{12} = 1$$

The solution of the former is

$$m_{12} = \frac{1}{m_{01}}$$

and of the latter

$$m_{12} = \frac{1 - m_{01} + m_{01} t_{01} (1 - k_0)}{m_{01} t_{01} (1 - k_0 m_{01})}$$

Although m_{12} must be positive, there may be cases where $m_{01} > 1$ and $t_{01} < 1$ for which the solution is negative. In these cases the range of inconsistency extends from 0 to $\frac{1}{m_{01}}$

1.8. The algebraic size of the range will be given by:

$$R = \frac{1 - m_{01} + m_{01} t_{01} (1 - k_0)}{m_{01} t_{01} (1 - k_0 m_{01})} - \frac{1}{m_{01}}$$

$$= \frac{(1 - m_{01})(1 - t_{01})}{m_{01} t_{01} (1 - k_0 m_{01})}.$$

* † ‡ See corresponding footnotes on previous page.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Since we take $k_0 m_{01} < 1$, $R > 0$ if m_{01} and t_{01} lie on the same side of unity, and $R < 0$ if m_{01} and t_{01} lie on opposite sides of unity. This can be seen in the diagram.

1.9. The size of the range depends on the parameters k_0, m_{01} and t_{01}. The way in which it varies as they vary can be seen by differentiating R with respect to these variables. We have

$$\frac{\partial R}{\partial t_{01}} = -\frac{1}{t_{01}^2} \cdot \frac{1 - m_{01}}{m_{01}(1 - k_0 m_{01})}.$$

Since we take $k_0 m_{01} < 1$, we have

$$\frac{\partial R}{\partial t_{01}} \gtrless 0 \text{ according as } m_{01} \gtrless 1,$$

i.e., R is a monotonic function in t_{01}, increasing for $m_{01} > 1$ and decreasing for $m_{01} < 1$ over the relevant range. Bearing in mind that $k_0 m_{01} < 1$ and $k_0 m_{01} t_{01} < 1$ we can sketch R for the relevant range of t_{01} as follows:

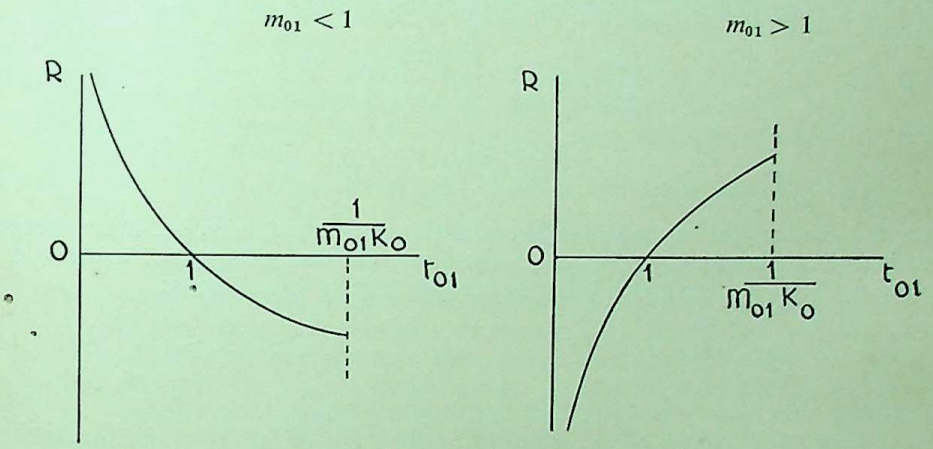


FIG. 2

Thus the absolute magnitude of R increases the further away from unity is t_{01}.

Again

$$\frac{\partial R}{\partial m_{01}} = -\frac{1 - t_{01}}{t_{01}} \cdot \frac{(1 - 2k_0 m_{01} + k_0 m_{01}^2)}{m_{01}^2 (1 - k_0 m_{01})^2}$$

$$= -\frac{1 - t_{01}}{t_{01}} \cdot \frac{k_0 \left[(1 - m_{01})^2 + \left(\frac{1}{k_0} - 1 \right) \right]}{m_{01}^2 (1 - k_0 m_{01})^2}$$

Hence

$$\frac{\partial R}{\partial m_{01}} \gtrless 0 \text{ according as } t_{01} \gtrless 1,$$

i.e., R is a monotonic function in m_{01}, increasing for $t_{01} > 1$ and decreasing for $t_{01} < 1$. We can sketch R for the relevant range of t_{01} as follows:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

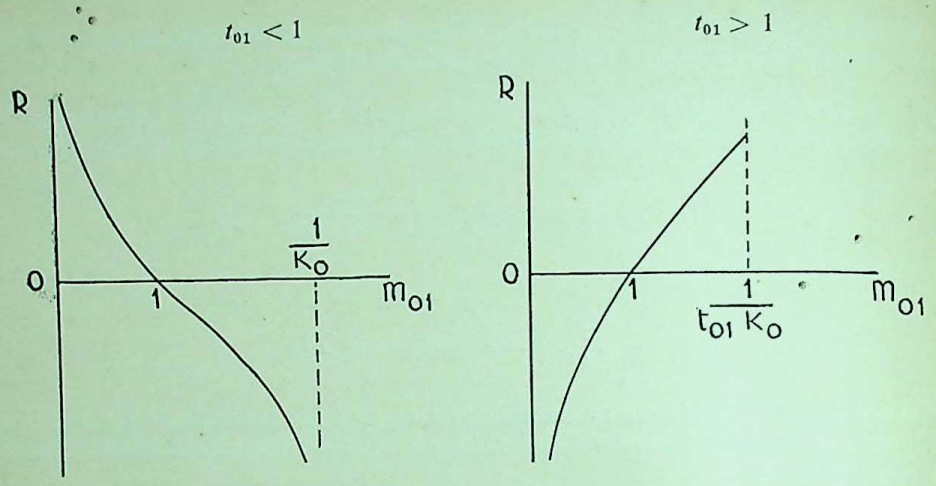


FIG. 3

Thus the absolute magnitude of R increases the further away from unity is m_{01}.

Again

$$\frac{\partial R}{\partial k_0} = \frac{1 - t_{01}}{t_{01}} \cdot \frac{1 - m_{01}}{(1 - k_0 m_{01})^2}$$

Hence

$$\frac{\partial R}{\partial k_0} \gtrless 0,$$

according as t_{01} and m_{01} are on the same side or on different sides of unity, i.e., R is a monotonic function in k_0 increasing for t_{01} and $m_{01} > 1$ or < 1 and decreasing for $t_{01} > 1$ and $m_{01} < 1$ or $t_{01} < 1$ and $m_{01} > 1$. We can sketch R for the relevant range of k_0 as follows:

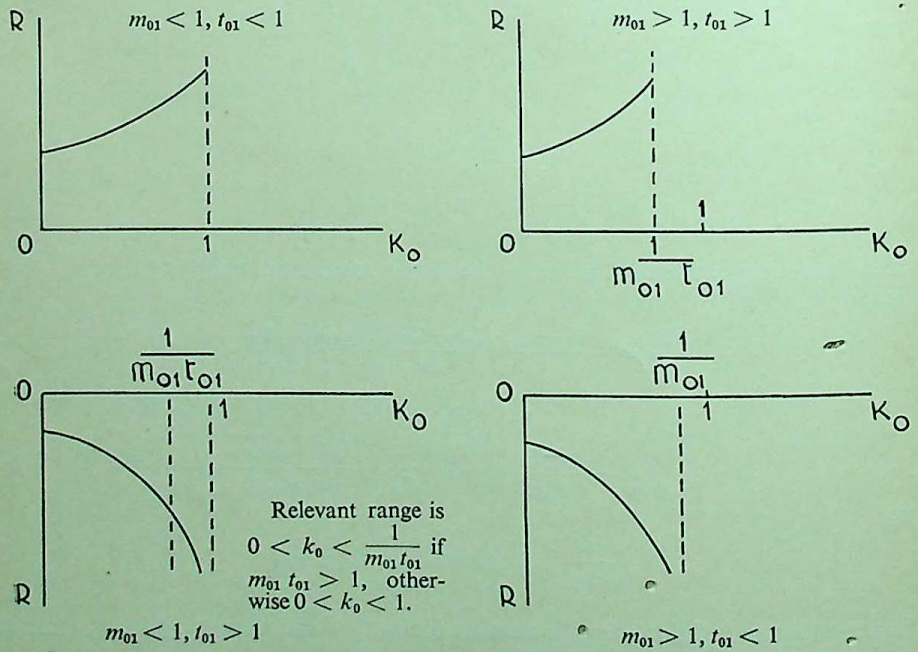


FIG. 4

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Thus the absolute magnitude of R increases the nearer to unity is k_0.

1.10. We can conclude that when comparisons of the quanta of input, gross output and net output between periods 0 and 2 are being made by a chaining process via period 1, inconsistent results for the period 2 indexes will be obtained if all the following conditions hold:

(1) if the index of input quantum has moved differently from the index of output quantum over periods 0 to 1, i.e. $m_{01} \neq 1$;

(2) if the index of input prices has moved differently from the index of output prices over periods 0 to 1, i.e. $t_{01} \neq 1$;

(3) if the movement in the index of input quantum relatively to the index of output quantum over periods 1 to 2 lies within a particular range, i.e.

$$m_{12} \text{ lies within } \frac{1}{m_{01}} \text{ to } \frac{1 - m_{01} + m_{01}\, t_{01}\,(1 - k_0)}{m_{01}\, t_{01}\,(1 - k_0\, m_{01})}$$

For (3) to be fulfilled it is necessary at least that the movement in the index of input quantum relatively to that of output quantum over periods 1 to 2 should be in the opposite direction to the corresponding movement over periods 0 to 1, i.e. for $m_{01} < 1, m_{12} > 1$ and for $m_{01} > 1$, $m_{12} < 1$.

Further, the size of the range of values for m_{12} which will lead to inconsistency given the above conditions will be greater in absolute magnitude:

(1) the greater the movement of the index of input quantum relatively to that of output quantum, other things being equal, i.e. the further m_{01} from 1;

(2) the greater the movement of the index of input prices relatively to that of output prices, other things being equal, i.e. the further t_{01} from 1;

(3) the greater the ratio of the value of input to the value of output in period 0, i.e. the higher k_0.

2. Empirical

2.1. The question now arises, are inconsistencies likely to be of importance in practice? The range of inconsistency for m_{12} depends on the parameters m_{01}, t_{01} and k_0. An indication of the arithmetic magnitudes of these parameters which can occur in practice is given in Table 1. This table, and all subsequent tables are based on computations made by Mr. R. R. Hirst of the Department of Economics, University of Adelaide, in connection with an investigation into the productivity of the Food, Drink and Tobacco Industries for Australia 1936–37 to 1950–51.* It is not suggested that this investigation was in any sense representative.

It will be seen from the table that about three-quarters of the m_{01} and t_{01} values lie between 0·95 and 1·05. This is as expected, because input quantities are not likely to move very differently from output quantities and similarly for input and output prices. However, m_{01} ranges from 0·809 to 1·219 and t_{01} from 0·870 to 1·331, so that extreme values are occasionally recorded. About three-quarters of the m_{01} and t_{01} values lie on opposite sides of unity. This means that in general when input prices rise relatively to output prices, input quantities tend to fall relatively to output quantities and *vice-versa*. This is the normal substitution effect, although it must be limited by technical considerations. In practice it might also be brought about by inventory movements which in principle should be eliminated from the input and output quantities but which cannot always be detected in published statistics. The values of k_0 vary a good deal of course as between industrial sectors and in some sectors time-trends are evident. In the data presented in Table 1, k_0 varies between about 0·4 and 0·9.

2.2. In Table 2 are shown the values of m_{12} which will produce inconsistent orderings for given values of m_{01}, t_{01} and k_0.

* The results of this investigation were presented by R. R. Hirst to the 1954 meeting of the Australian and New Zealand Association for the Advancement of Science in a paper entitled "The Measurement of Industrial Production".

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 1

Values of m_{01}, t_{01} *and* k_0 *for some Australian industries*, 1937–38 *to* 1950–51

(*The subscript* $_1$ *refers to the stated year and the subscript* $_0$ *refers to the preceding stated year*)

	1937–8	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Flour Milling and Cereal Foods														
m_{01}	0·964	1·022	0·992					1·019	0·946	1·014	0·988	0·989	1·007	1·005
t_{01}	1·046	0·913	0·992					1·023	1·058	0·979	1·040	1·018	0·979	0·991
k_0	0·839	0·846	0·789					0·776	0·809	0·809	0·804	0·826	0·832	0·821
Bakeries														
m_{01}	0·972	0·984	1·009					0·976	1·005	0·993	1·055	0·965	1·031	1·011
t_{01}	1·008	0·998	1·027					1·013	0·987	0·984	0·971	1·031	0·945	0·985
k_0	0·631	0·618	0·607					0·629	0·621	0·616	0·602	0·617	0·614	0·598
Bicuits														
m_{01}	1·184	1·002	0·995					0·895	0·993	1·056	0·976	1·031	1·058	0·930
t_{01}	0·870	1·003	0·990					0·992	1·057	0·948	1·037	0·959	0·993	1·018
k_0	0·549	0·565	0·568					0·560	0·497	0·521	0·522	0·528	0·523	0·550
Confectionery														
m_{01}	0·974	1·015	0·989				0·973	0·960	1·088	1·056	0·939	0·998	1·058	0·997
t_{01}	1·020	0·961	0·990				1·067	1·050	0·930	1·069	0·974	0·994	0·930	1·026
k_0	0·589	0·585	0·570				0·558	0·580	0·585	0·592	0·668	0·611	0·607	0·597
Jam, Fruit and Veg. Canning														
m_{01}	0·919	0·985	1·017					0·985	1·032	1·013	0·967	1·002	0·999	
t_{01}	1·062	1·026	0·973					1·054	0·986	0·935	1·031	0·996	1·001	
k_0	0·708	0·691	0·698					0·691	0·717	0·730	0·692	0·689	0·688	
Pickles, Sauces and Vinegar														
m_{01}		1·042	1·006					0·923	0·993	1·100	1·007	0·967	1·044	
t_{01}		0·940	1·008					1·172	1·006	0·950	0·981	1·028	0·969	
k_0		0·602	0·590					0·598	0·647	0·646	0·675	0·667	0·663	

	1937–8	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Bacon Curing														
m_{01} . .	1·010	1·072	0·980				0·869	0·943	0·946	0·994	0·939	1·085	0·917	1·086
t_{01} . .	0·970	0·965	1·030				1·204	1·032	1·076	1·012	1·064	0·918	1·082	0·902
k_0 . .	0·805	0·789	0·816				0·823	0·862	0·839	0·854	0·858	0·857	0·854	0·848
Butter, Cheese and Condensed Milk														
m_{01} . .	1·010	1·003	0·981				1·037	0·971	1·003	1·016	0·975	1·035	0·976	1·005
t_{01} . .	0·981	1·023	1·008				0·966	1·011	1·006	0·970	1·026	0·984	1·030	0·960
k_0 . .	0·878	0·870	0·893				0·883	0·885	0·869	0·877	0·864	0·864	0·880	0·885
Aerated Waters and Cordials														
m_{01} . .	0·972	1·048	1·073				1·219	0·986	0·946	0·958	1·015	1·000	1·036	0·971
t_{01} . .	1·063	0·988	0·962				0·969	1·001	1·016	1·012	0·992	0·993	0·995	1·000
k_0 . .	0·450	0·465	0·481				0·497	0·587	0·579	0·556	0·540	0·544	0·540	0·556
Breweries														
m_{01} . .	0·946	1·004	0·997	0·990	0·986	1·000	0·987	1·000	0·987	1·005	1·000	0·998	1·009	0·995
t_{01} . .	1·121	0·994	0·999	1·074	1·083	0·967	0·999	1·011	1·009	1·000	1·052	1·080	1·034	1·038
k_0 . .	0·383	0·406	0·405	0·404	0·429	0·458	0·443	0·437	0·442	0·440	0·442	0·465	0·502	0·523
Malting														
m_{01} . .	1·141	0·999	1·005	0·866	1·074	1·004	1·005	0·969	1·013	1·043	0·981	1·015	0·986	1·028
t_{01} . .	0·908	0·974	1·001	1·183	0·981	0·955	1·041	1·012	1·005	0·993	1·027	0·970	0·977	0·953
k_0 . .	0·659	0·683	0·664	0·668	0·685	0·722	0·690	0·721	0·708	0·720	0·746	0·751	0·739	0·712
Tobacco, Cigars and Cigarettes														
m_{01} . .	0·996	1·000	1·025				0·990	1·002	1·006	1·013	1·046	0·991	0·994	0·968
t_{01} . .	0·995	1·001	0·986				1·077	1·039	0·996	1·013	0·927	0·974	1·020	1·003
k_0 . .	0·732	0·725	0·726				0·734	0·783	0·816	0·817	0·838	0·812	0·785	0·796
ce Cream														
m_{01} . .	1·107	0·960	0·946				0·841	1·010	1·012	1·110	0·995	0·809	0.987	0·905
t_{01} . .	0·960	1·021	1·069				1·331	0·972	1·022	0·964	1·038	1·325	1·047	1·078
k_0 . .	0·415	0·441	0·432				0·437	0·489	0·480	0·496	0·531	0·549	0·588	0·607

CC-0.In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Range of values for m_{12} *which will produce inconsistent orderings for given* m_{01}, t_{01} *and* k_0

m_{01} \ t_{01}		0·8	0·9	0·95	1·05	1·1	1·2
0·8	$k_0 = 0{\cdot}4$	1·250, 1·342	1·250, 1·291	1·250, 1·269	1·232, 1·250	1·217, 1·250	1·189, 1·250
	0·65	1·250, 1·380	1·250, 1·308	1·250, 1·277	1·225, 1·250	1·203, 1·250	1·163, 1·250
	0·9	1·250, 1·473	1·250, 1·349	1·250, 1·297	1·207, 1·250	1·169, 1·250	1·101, 1·250
0·9	$k_0 = 0{\cdot}4$	1·111, 1·155	1·111, 1·130	1·111, 1·120	1·103, 1·111	1·095, 1·111	1·082, 1·111
	0·65	1·111, 1·178	1·111, 1·141	1·111, 1·125	1·098, 1·111	1·087, 1·111	1·066, 1·111
	0·9	1·111, 1·257	1·111, 1·176	1·111, 1·142	1·083, 1·111	1·058, 1·111	1·014, 1·111
0·95	$k_0 = 0{\cdot}4$	1·053, 1·074	1·053, 1·062	1.053, 1.057	1·049, 1·053	1·045, 1·053	1·038, 1·053
	0·65	1·053, 1·087	1·053, 1·068	1·053, 1·060	1·046, 1·053	1·040, 1·053	1·030, 1·053
	0·9	1·053, 1·143	1·053, 1·093	1·053, 1·072	1·035, 1·053	1·020, 1·053	(*a*)
1·05	$k_0 = 0{\cdot}4$	0·932, 0·952	0·943, 0·952	0·948, 0·952	0·952, 0·956	0·952, 0·960	0·952, 0·966
	0·65	0·915, 0·952	0·937, 0·952	0·944, 0·952	0·952, 0·959	0·952, 0·966	0·952, 0·977
	0·9	0·736, 0·952	0·857, 0·952	0·907, 0·952	0·952, 0·994	(*a*)	(*a*)
1·1	$k_0 = 0{\cdot}4$	0·868, 0·909	0·891, 0·909	0·900, 0·909	0·909, 0·917	0·909, 0·924	0·909, 0·936
	0·65	0·829, 0·909	0·874, 0·909	0·892, 0·909	0·909, 0·924	0·909, 0·938	0·909, 0·962
	0·9	0·000, 0·909	0·000, 0·909	0·431, 0·909	(*a*)	(*a*)	(*a*)
1·2	$k_0 = 0{\cdot}4$	0·753, 0·833	0·798, 0·833	0·816, 0·833	0·833, 0·849	0·833, 0·862	0·833, 0·887
	0·65	0·644, 0·833	0·749, 0·833	0·793, 0·833	0·833, 0·869	0·833, 0·902	0·833, 0·960
	0·9	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)

(*a*) The values of m_{01}, t_{01} and k_0 which produce these cells cannot occur in practice because, for these cells $m_{01} k_0 > 1$ or $m_{01} t_{01} k_0 > 1$.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It will be seen from the table that the ranges for m_{12} are in general small unless m_{01} and t_{01} are well away from unity and k_0 is close to unity. The smallness of the ranges for m_{12} suggests that inconsistencies would in practice be rare. The Australian data can be used to test this.

2.3. Table 3 gives year to year comparisons of the quantum of input, gross output and net output for the same industries as Table 1. These were obtained by deflating values of input and gross output by the appropriate Paasche Price Indexes on a year to year basis.* Adequate data were not available for most of the industries during the war years, so that in some cases comparisons had to be made between 1943–44 or 1944–45 and 1939–40. Since all comparisons in this table are point-to-point, no inconsistencies can occur. This can be verified from the table. Table 4 is obtained by multiplying the indexes in Table 3 in pairs, so that it compares the levels of input, gross output and net output, not with the previous stated year as in Table 3, but with the stated year prior to that one. In other words the indexes in Table 4 are chained indexes with two links and correspond to the case taken in the theoretical analysis above.

Out of the 128 sets of index numbers in this table there are only *two* inconsistent sets, namely those for Bacon Curing 1949–50 and 1950–51. This tends to confirm the *a priori* belief that inconsistencies in paired links are not likely to occur often in practice.

2.4. The analysis has so far been concerned with chained indexes involving only two links, since with more than two links the algebra becomes too complex. However, in practice chained indexes always involve more than two links and the number of links grows as time passes.

Table 5 gives the progressive chaining of the year to year links shown in Table 3. There are *five* sets of inconsistent indexes, shown by boxes. This compares with *two* sets when links are chained in pairs. A comparison of the table with Table 4 suggests that three considerations must be borne in mind in discussing the effects of progressive chaining. Writing $S_{0,t}$ for the set of input, gross output and net output index numbers, calculated by chaining links between periods 0 and t and $S_{t,t+1}$ for the set of links comparing periods t and $t+1$, we will have for the set of chained indexes at period $t+1$:

$$S_{0,t+1} = S_{0,t} \cdot S_{t,t+1}.$$

Hence:

(1) If the set $S_{0,t}$ is inconsistent then $S_{0,t+1}$ may easily be inconsistent even if the set of pairs of links $S_{1-t,t} \cdot S_{t,t+1}$ is consistent. This will certainly happen if $m_{t,t+1} = 1$. Thus once an inconsistency is obtained in the chain it may well be repeated. An example of this in Table 5 is Ice Cream 1947–48 and 1948–49.

(2) Even if all the paired links in the set $S_{0,t+1}$ are consistent, $S_{0,t+1}$ may still be inconsistent. This is analogous to the situation where a pair of links produces inconsistency, even though the links separately must be consistent. Comparing Tables 4 and 5 it can be seen that this has happened for some years in Confectionery, Butter, Malting and Ice Cream.

(3) Even if some of the paired links in the set $S_{0,t+1}$ are inconsistent, $S_{0,t+1}$ may still be consistent. This has occurred in Bacon Curing in Tables 4 and 5.

Finally it should be noted that inconsistencies can be produced simply by altering the base of of the chained index (and conversely inconsistencies can be eliminated by the same process). Thus for example the indexes for input, gross output and net output for Malting 1943–44 on a base of 1936–37 = 100 are 160·1, 148·9 and 111·7 respectively. These are consistent. However, if the

* For each year to year comparison, we have

$$v_0 = \Sigma p_0 q_0,\ V_0 = \Sigma P_0 Q_0,\ v_1 = \Sigma p_1 q_1,\ V_1 = \Sigma P_1 Q_1,$$

$$p_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \text{ and } P_{01} = \frac{\Sigma P_1 Q_1}{\Sigma P_0 Q_1}.$$

Then

$$I_{01} = v_1/v_0 \div p_{01}$$

and

$$G_{01} = V_1/V_0 \div P_{01}$$

and

$$N_{01} = \frac{V_1 \div P_{01} - v_1 \div p_{01}}{V_0 - v_0}$$

The price indexes used were calculated on a sample basis.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 3

Year to year links of quantum of Input, Gross Output and Net Output for some Australian industries* 1936–7 *to* 1950–1

	1937–8	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Flour Milling and Cereal Foods														
Input . .	101·2	111·2	101·0					116·5	86·9	119·4	102·5	103·3	91·4	109·3
Gross Output	105·0	108·8	101·8					114·2	91·9	117·7	103·7	104·4	90·8	108·8
Net Output .	125·1	95·9	104·9					106·3	113·3	110·1	108·8	109·6	87·9	106·7
Bakeries														
Input . .	99·2	103·8	103·7					129·1	106·0	100·3	110·1	102·6	110·7	102·0
Gross Output	102·1	105·5	102·8					132·4	105·5	101·0	104·4	106·3	107·4	100·9
Net Output .	107·2	108·1	101·3					138·0	104·8	102·1	95·7	112·2	102·2	99·2
Biscuits														
Input . .	112·7	100·9	102·9					123·2	84·0	107·6	103·3	108·9	122·0	102·6
Gross Output	95·2	100·7	103·4					137·8	84·6	101·9	105·8	105·6	115·3	110·3
Net Output .	73·9	100·4	104·2					156·4	85·3	95·7	108·6	101·9	108·0	119·7
Confectionery														
Input .	101·5	105·4	104·2				109·7	98·4	109·8	116·9	88·1	104·2	116·8	94·2
Gross Output	104·2	103·8	105·4				112·7	102·5	100·9	110·7	93·8	104·4	110·4	94·5
Net Output .	108·1	101·5	107·0				116·5	108·2	88·3	101·7	105·2	104·6	100·4	95·1
Jam, Fruit and Veg. Canning														
Input . .	105·0	101·9	121·8					184·9	88·0	95·9	109·8	91·4	106·8	
Gross Output	114·2	103·5	119·8					187·8	85·3	94·7	113·6	91·2	106·9	
Net Output .	136·4	107·2	115·1					194·3	78·6	92·0	122·1	90·7	107·0	
Pickles, Sauces and Vinegar														
Input . .		97·4	107·6					145·1	99·5	119·1	101·4	107·8	101·6	
Gross Output		93·5	107·0					157·2	100·2	108·3	100·7	111·5	97·3	
Net Output .		87·7	106·0					175·4	101·6	88·7	99·0	118·7	88·9	

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	1937–8	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Bacon Curing														
Input . .	98·6	109·8	111·9				111·7	117·4	89·5	92·0	91·8	104·5	89·7	97·0
Gross Output	97·6	102·4	114·2				128·5	124·5	94·6	92·6	97·8	96·3	97·8	89·3
Net Output .	93·4	75·1	124·5				206·7	168·8	121·4	96·7	134·3	45·7	145·3	46·8
Butter, Cheese and Condensed Milk														
Input . .	115·1	105·4	103·9				99·7	88·4	104.4	96·9	108·2	103·4	106·6	97·5
Gross Output	114·0	105·1	105·9				96·1	91·0	104·1	95·4	111·0	99·9	109·2	97·0
Net Output .	105·7	103·4	122·9				68·8	110·1	102·1	84·9	128·7	77·7	127·9	92·1
Aerated Waters and Cordials														
Input . .	122·7	113·0	108·8				212·9	113·7	97·2	96·7	106·6	107·8	115·9	104·1
Gross Output	126·3	107·8	101·4				174·7	115·3	102·8	100·9	105·0	107·8	111·9	107·2
Net Output .	129·2	103·2	94·5				137·0	135·0	110·4	106·2	103·1	107·8	107·1	111·1
Breweries														
Input . .	116·3	105·9	105·0	108·9	102·8	87·7	103·3	100·9	104·5	119·6	99·0	113·1	110·0	109·3
Gross Output	122·9	105·5	105·3	110·0	104·3	87·7	104·7	100·9	105·9	119·0	99·0	113·3	109·0	109·8
Net Output .	127·0	105·2	105·6	110·8	105·2	87·8	105·9	100·9	107·0	118·6	99·0	113·5	108·0	110·3
Malting														
Input . .	133·6	116·3	98·6	99·0	101·7	95·3	108·9	91·4	102·4	127·0	102·6	105·5	107·1	108·2
Gross Output	117·1	116·4	98·1	114·3	94·7	94·9	108·4	94·3	101·1	121·8	104·6	103·9	108·6	105·3
Net Output .	85·2	116·5	97·3	145·2	79·2	93·9	107·1	101·6	97·8	108·6	110·4	98·9	112·8	98·4
Tobacco, Cigars and Cigarettes														
Input . .	105·2	102·6	106·4				113·3	96·9	100·3	119·7	104·5	93·0	105·2	100·7
Gross Output	105·6	102·6	103·8				114·4	96·7	99·7	118·2	99·9	93·8	105·8	104·0
Net Output .	106·5	102·6	97·0				117·4	96·0	96·7	111·7	76·2	97·5	107·7	116·8
Ice Cream														
Input . .	131·4	103·6	97·3				183·0	103·2	107·4	119·8	110·4	93·3	105·9	100·9
Gross Output	118·7	107·9	102·9				217·7	102·2	106·1	107·9	110·9	115·4	107·3	111·5
Net Output .	109·8	111·3	107·1				244·7	101·2	104·8	96·1	111·5	142·4	109·3	128·0

* The figures give levels of quantum measured relatively to the preceding stated year. Thus Ice Cream Input of 97·3 for 1939–40 means that the level in that year was 97·3 per cent. of the level in 1938–9 and Ice Cream Input of 183·0 for 1943–4 means that the level in that year was 183·0 per cent. of the level in 1939–40.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Paired links of quantum of Input, Gross Output and Net Output for some Australian industries* 1938–9 *to* 1950–1

	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Flour Milling and Cereal Foods													
Input . . .	112·5	112·3					117·7	101·2	103·8	122·4	105·9	94·4	99·9
Gross Output . .	114·2	110·8					116·3	104·9	108·2	122·1	108·3	94·8	98·8
Net Output . .	120·0	100·6					111·5	120·2	124·7	119·8	119·2	96·3	93·8
Bakeries													
Input . . .	103·0	107·6					133·9	136·8	106·3	110·4	113·0	113·6	112·9
Gross Output . .	107·7	108·5					136·1	139·7	106·6	105·4	111·0	114·2	108·4
Net Output . .	115·9	109·5					139·8	144·6	107·0	97·7	107·4	114·7	101·4
Biscuits													
Input . . .	113·7	103·8					126·8	103·5	90·4	111·2	112·5	132·9	125·2
Gross Output . .	95·9	104·1					142·5	116·6	86·2	107·8	111·7	121·8	127·2
Net Output . .	74·2	104·6					163·0	133·4	81·6	103·9	110·7	110·1	129·3
Confectionery													
Input . . .	107·0	109·8				114·3	107·9	108·0	128·4	103·0	91·8	121·7	110·0
Gross Output . .	108·2	109·4				118·8	115·5	103·4	111·7	103·8	97·9	115·3	104·3
Net Output . .	109·7	108·6				124·7	126·1	95·5	89·8	107·0	110·0	105·0	95·5
Jam, Fruit and Veg. Canning													
Input . . .	107·0	124·1					225·2	162·7	84·4	105·3	100·4	97·6	
Gross Output . .	118·2	124·0					225·0	160·2	80·8	107·6	103·6	97·5	
Net Output . .	146·2	123·4					223·6	152·7	72·3	112·3	110·7	97·0	
Pickles, Sauces and Vinegar													
Input . . .		104·8					156·1	144·4	118·5	120·8	109·3	109·5	
Gross Output . .		100·0					168·2	157·5	108·5	109·1	112·3	108·5	
Net Output . .		93·0					185·9	178·2	90·1	87·8	117·5	105·5	

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Bacon Curing													
Input	108·3	122·9				125·0	131·1	105·1	82·3	84·5	95·9	93·7	87·0
Gross Output	99·9	116·9				146·7	160·0	117·8	87·6	90·6	94·2	94·2	87·3
Net Output	70·1	93·5				257·3	348·9	204·9	117·4	129·9	61·4	66·4	68·0
Butter, Cheese and Condensed Milk													
Input	121·3	109·5				103·6	88·1	92·3	101·2	104·8	111·9	110·2	103·9
Gross Output	119·8	111·3				101·8	87·5	94·7	99·3	105·9	110·9	109·1	105·9
Net Output	109·3	127·1				84·6	75·7	112·4	86·7	109·3	100·0	99·4	117·5
Aerated Waters and Cordials													
Input	138·7	122·9				231·6	242·1	110·5	94·0	103·1	114·9	124·9	120·7
Gross Output	136·2	109·3				177·1	201·4	118·5	103·7	105·9	113·2	120·6	120·0
Net Output	133·3	97·5				129·5	185·0	149·0	117·2	109·5	111·1	115·5	119·0
Breweries													
Input	123·2	111·2	114·3	111·9	90·2	90·6	104·2	105·4	125·0	118·4	112·0	124·4	120·2
Gross Output	129·7	111·1	115·8	114·7	91·5	91·8	105·6	106·9	126·0	117·8	112·2	123·5	119·7
Net Output	133·6	111·1	117·0	116·6	92·4	93·0	106·9	108·0	126·9	117·4	112·4	122·6	119·1
Malting													
Input	155·4	114·7	97·6	100·7	96·9	103·8	99·5	93·6	130·0	130·3	108·2	113·0	115·9
Gross Output	136·3	114·2	112·1	108·2	89·9	102·9	102·2	95·3	123·1	127·4	108·7	112·8	114·4
Net Output	99·3	133·4	141·3	115·0	74·4	100·6	108·8	99·4	106·2	119·9	109·2	111·6	111·0
Tobacco, Cigars and Cigarettes													
Input	107·9	109·2				120·6	109·8	97·2	120·1	125·1	97·2	97·8	105·9
Gross Output	108·3	106·5				118·7	110·6	96·4	117·8	118·1	93·7	99·2	110·0
Net Output	109·3	99·5				113·9	112·7	92·8	108·0	85·1	74·3	105·0	125·8
Ice Cream													
Input	136·1	100·8				178·1	188·9	110·8	128·7	132·3	103·0	98·8	106·9
Gross Output	128·1	111·0				224·0	222·5	108·4	114·5	119·7	128·0	123·8	119·6
Net Output	122·2	119·2				262·1	247·6	106·1	100·7	107·2	158·8	155·6	139·9

* The figures give levels of quantum measured relatively to the second preceding stated year. Thus Ice Cream Input of 100·8 for 1939–40 means that the level in that year was 100·8 per cent. of the level in 1937–8 and Ice Cream Input of 178·1 for 1943–4 means that the level in that year was 178·1 per cent. of the level in 1938–9.

(*Note:* Comparing Tables 3 and 4, we have $100·8 = 103·6 \times 97·3 \div 100$ and $178·1 = 97·3 \times 183·0 \div 100$.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

base is shifted to the average of the three years 1936–37 to 1938–39 = 100 by dividing through the original chained index by the appropriate average index numbers for the new base period, the index numbers become 123·4, 126·2, 117·8 and these are inconsistent.

3. CONCLUSIONS

3·1. The preceding analysis has shown that chained indexes of quantum of input, gross output and net output can throw up nonsensical results. Thus in a comparison of 1947–48 and 1936–37, the Australian Butter, Cheese and Condensed Milk industry showed an increase in gross output of 22·3 per cent., an increase in input of 21·6 per cent. and an increase in net output of only 13·5 per cent., instead of an increase of something more than 22·3 per cent. These nonsensical results throw doubt on the use of chaining in this kind of work. Nor can the fact that inconsistencies do not occur very frequently be taken as a mitigating factor. The possibility of inconsistency is inherent in the method. A very slight change in one of the key variables can easily turn what appears to be consistent results into inconsistent ones.

If we could define an "ideal" measure of quantum changes, at least conceptually if not statistically, then we could attempt to discover whether a particular index formula was "biased" or "true". However, we are not in this happy position. All we can say is that if we have three chained indexes of quantum of input, gross output and net output they cannot all be "true"; but no sense can be attached to saying that one or another of them is "biased".

3.2. In itself a chaining process seems reasonable. If output has gone up from 1 to X from time t to $t + 1$ and from 1 to Y from time $t + 1$ to $t + 2$ it seems logical to say that it has gone up from 1 to XY from time t to $t + 2$. The catch is, of course, that the meaning of "output" may have changed as between the two links, because the method of valuation may have changed. Thus the meaning of a chained index is never very clear. In this respect an index with constant weights has a big advantage. On the other hand an index with constant weights suffers from the very big disadvantage of increasing out-of-dateness of the weights. Chaining is usually used in an attempt to keep the weights up-to-date.

3.3. There seems to be no satisfactory way out of this dilemma. However, if we incline towards chaining for the reason given at the end of the last paragraph, we could proceed in the following way. We could accept the input and gross output chained indexes as being reasonable and combine them by using constant values of input and gross output, which is the same as combining them by using a constant ratio of value of input to value of output. Thus we would have:

$$N'_{0t} = \frac{G_{0t} - k\, I_{0t}}{1 - k}$$

where G and I are chained indexes and k is the ratio of value of input to value of output in some base period.

This method would prove satisfactory, subject to the limitations of the chained indexes G and I themselves, so long as k remains approximately constant at $k_t = k$. In fact for some industrial sectors k_t does not change greatly. If k_t does change much we are back to the problem of out-of-dateness of weights. Constancy in k_t implies that both input prices move parallel with output prices and input quantities move parallel with output quantities (if this happened exactly no inconsistencies could arise anyhow); or that divergencies between the two price levels are just offset by divergencies in the opposite direction between the two quantum levels.

Index number puzzles usually arise because different formulae give different results. In the case discussed here one formula gives mutually inconsistent results. But both types of problems arise from the same cause. Different formulae can give different results when both relative prices change and relative quantities change. The inconsistency problem discussed above arises in a situation in which three index numbers (input, gross output and net output) are considered simultaneously and one of them (net output) is itself an index number of the other two. In this case inconsistencies can occur when both input prices as a whole change relatively to output prices as a whole and input quantities as a whole change relatively to output quantities as a whole.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 5

Quantum of Input, Gross Output and Net Output of some Australian industries 1937–8 *to* 1950–1
Base: 1936–7 = 100

	1937–8	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Flour Milling and Cereal Foods														
Input . .	101·2	112·5	113·7					132·4	115·1	137·3	140·7	145·4	132·9	145·2
Gross Output	105·0	114·2	116·3					132·8	122·1	143·7	149·0	155·5	141·2	153·6
Net Output .	125·1	119·8	125·8					133·5	151·6	166·9	181·6	199·0	174·9	186·6
Bakeries														
Input . .	99·2	103·0	106·8					137·8	146·1	146·5	161·3	165·5	183·2	186·9
Gross Output	102·1	107·7	110·7					146·6	154·7	156·2	163·1	173·3	186·2	187·8
Net Output .	107·2	115·9	117·4					162·0	169·8	173·3	165·9	186·1	190·2	188·6
Biscuits														
Input . .	112·7	113·7	117·0					144·1	121·1	130·3	134·6	146·5	178·8	183·4
Gross Output	95·2	95·9	99·1					136·6	115·6	117·7	124·6	131·5	151·7	167·3
Net Output .	73·9	74·2	77·3					120·9	103·1	98·7	107·2	109·2	117·9	141·1
Confectionery														
Input . .	101·5	107·0	111·5				122·3	120·3	132·1	154·4	136·1	141·8	165·6	156·0
Gross Output	104·2	108·2	114·0				128·5	131·7	132·9	147·1	137·9	144·0	159·0	150·2
Net Output .	108·1	109.7	117·4				136·8	148·0	130·7	132·9	139·8	146·2	146·8	139·6
Jam, Fruit and Veg. Canning														
Input . .	105·0	107·0	130·3					240·9	212·0	203·3	223·2	204·0	217·9	
Gross Output	114·2	118·2	141·6					265·9	226·8	214·8	244·0	222·5	237·9	
Net Output .	136·4	146·2	168·3					327·0	257·0	236·4	288.7	261.8	280.2	
Pickles, Sauces and Vinegar (a)														
Input . .		97·4	104·8					152·1	151·3	180·2	182·7	197·0	200·1	
Gross Output		93·5	100·0					157·3	157·6	170·6	171·8	191·6	186·4	
Net Output .		87·7	93·0					163·1	165·7	146·9	145·5	172·7	153·5	
Bacon Curing														
Input . .	98·6	108·3	121·1				135·3	158·9	142·2	130·8	120·1	125·5	112·5	109·2
Gross Output	97·6	99·9	114·1				146·7	182·6	172·7	159·9	156·4	150·6	147·3	131·5
Net Output .	93·4	70·1	87·3				180·5	304·7	369·9	357·7	480·4	219·5	318·9	147·6

Digitized by Arya Samaj Foundation Chennai and eGangotri
CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 5 (*cont.*)

Quantum of Input, Gross Output and Net Output of some Australian industries 1937–8 *to* 1950–1

Base: 1936–7 = 100

	1937–8	1938–9	1939–40	1940–1	1941–2	1942–3	1943–4	1944–5	1945–6	1946–7	1947–8	1948–9	1949–50	1950–1
Butter, Cheese and Condensed Milk														
Input . .	115·1	121·3	126·0				125·7	111·1	116·0	112·4	121·6	125·7	134·0	130·6
Gross Output	114·0	119·8	126·9				121·9	110·9	115·5	110·2	122·3	122·1	133·4	129·4
Net Output .	105·7	109·3	134·3				92·4	101·7	103·9	88·2	113·5	88·2	112·8	103·9
Aerated Waters and Cordials														
Input . .	122·7	138·7	150·9				321·2	365·1	354·9	343·2	365·8	394·4	457·1	475·8
Gross Output	126·3	136·2	138·1				241·2	278·1	285·8	288·4	302·8	326·5	365·3	391·6
Net Output .	129·2	133·3	126·0				172·6	233·0	257·2	273·2	281·6	303·6	325·2	361·2
Breweries														
Input . .	116·3	123·2	129·3	140·8	144·8	126·9	131·1	132·3	138·3	165·3	163·7	185·1	203·6	222·6
Gross Output	122·9	129·7	136·5	150·2	156·6	137·4	143·8	145·1	153·7	182·8	181·0	205·1	223·5	245·4
Net Output .	127·0	133·6	141·1	156·3	164·4	144·4	152·9	154·2	165·0	195·7	193·8	219·9	237·5	262·0
Malting														
Input . .	133·6	155·4	153·2	151·7	154·2	147·0	160·1	146·3	149·8	190·2	195·2	205·9	220·5	238·6
Gross Output	117·1	136·3	133·7	152·8	144·7	137·3	148·9	140·4	141·9	172·9	180·8	187·9	204·0	214·8
Net Output .	85·2	99·3	96·6	140·2	111·1	104·3	111·7	113·5	111·0	120·5	133·0	131·6	148·4	146·0
Tobacco, Cigars and Cigarettes														
Input . .	105·2	107·9	114·8				130·1	126·1	126·4	151·3	158·1	147·1	154·7	155·8
Gross Output	105·6	108·3	112·5				128·6	124·4	124·0	146·6	146·4	137·3	145·3	151·1
Net Output .	106·5	109·3	106·0				124·4	119·4	115·5	129·0	98·3	95·8	103·2	120·5
Ice Cream														
Input . .	131·4	136·1	132·5				242·4	250·1	268·6	321·8	355·3	331·5	351·0	354·2
Gross Output	118·7	128·1	131·8				286·9	293·2	311·1	335·6	372·2	429·5	460·9	513·9
Net Output .	109·8	122·2	130·9				320·2	324·1	339·6	326·4	363·9	518·2	566·4	725·0

(*a*) Base 1937–8 = 100.

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Mode of a Grouped Distribution

By H. M. Finucan

If a frequency distribution is grouped into classes, it is an easy matter to find the modal class, but there is disagreement among text-books as to how the (point) mode of the distribution should be estimated. The problem is not of great importance (since the mean is a superior statistic), but is traditionally included in most books on statistical methods.

The usual notation is:

f_O = frequency in modal class

f_L, f_R = frequencies in adjacent left and right classes respectively

$d_L = f_O - f_L \qquad d_R = f_O - f_R.$

The formulae for the ratio in which the (point) mode divides the modal class are

(i) $d_L : d_R$; and (ii) $f_R : f_L$.

These are effectively contradictory; it is not the case that one is an approximation to the other. There is a genuine need to decide between them since, e.g., of 20 books inspected by the present writer, 10 quoted the *d* and 10 the *f* formula.

A simple test may be made which suggests that the *d* formula is more reliable. For a symmetrical unimodal distribution, the *d* formula gives correct results in the two extreme cases. Firstly, if the mid point of the modal class is at the centre of symmetry of the distribution (both *d*'s being equal) and, secondly, if one boundary of the modal class is at the centre of symmetry (one *d* being zero). The *f* formula above is correct for the first case, but not for the second. More generally, since the class intervals are "superimposed" on the data, the mode will sometimes lie near a class boundary; but with ordinary distributions and the usual number of classes, the *f* formula will locate the mode near the centre of the modal class. Thus the *f* formula must be wrong.

Another simple test also favours the *d* formula. It often happens that mathematical formulae are found to be more general than was apparent at first, and this generality is, in a way, a criterion of a good formula. Thus if we find the (point) mode of a unimodal distribution by "extrapolation", using adjacent frequencies f_L, f_O, f_R, where f_O does NOT now refer to the modal class, the *d*'s as defined above are of opposite signs and correctly indicate that the mode divides externally the f_O class. The *f* formula still gives a positive ratio of division which is, of course, wrong.

The simple tests described above are confirmed by reference to the mathematical literature. The *d* formula is in fact proved by Bowley (1948) and Yule and Kendall (1950); the present writer has not been able to find a proof of the *f* formula.

References

Bowley, A. L. (1948), *Elements of Statistics*. London: Staples.
Yule, G. Udny, & Kendall, M. G. (1950), *Introduction to the Theory of Statistics*. London: Griffin.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

First International Conference of National Committees on Vital and Health Statistics

The first International Conference of National Committees on Vital and Health Statistics, convened under the auspices of the World Health Organization in close collaboration with the United Nations, was held at the General Register Office, Somerset House, London, from October 12th to 17th, 1953.

The Conference was attended by delegates from 28 countries. Representatives of the International Labour Office and of the International Statistical Institute were also present.

The Conference was opened by Dr. H. S. Gear, Assistant Director General, Department of Central Technical Services, W.H.O., and was addressed at the opening session by the Minister of Health for England and Wales, Mr. Ian MacLeod and by Sir Walter Russell Brain, President of the Royal College of Physicians, who had been appointed Honorary President of the Conference. Professor A. Bradford Hill was elected Chairman of the Conference and the programme of work was carried out through two Committees, the first under the Chairmanship of Dr. P. F. Denoix (France) dealing with the general subject of the objectives, organization and programmes of National Committees or equivalent bodies as well as with types of health statistics and related vital statistics which would be of the greatest practical value to countries at different stages of development; and the second Committee under the Chairmanship of Dr. M. G. Neurdenburg (Netherlands), considering mainly the methods most suitable for improving the quality of health statistics and related vital statistics, for securing wide appreciation of their value, and reviewing also the situation as regards national implementation of international regulations or recommendations.

The following abridged account of the proceedings of the Conference is taken from the official W.H.O. Report.*

I. *National Committees on Vital and Health Statistics*

The Conference reviewed the objectives of National Committees and recommended that any government not yet having considered the formation of a National Committee should now review the practicability of doing so. In setting up such a Committee regard should be had *inter alia* to two points: (1) that the functions of the Committee would normally be advisory and consultative, in response to the requests from an appropriate government authority, but that it should, in appropriate circumstances, stimulate the undertaking of analysis, research and special studies; (2) that the membership of the Committee should include persons (administrative, professional and lay) among those concerned with the collection, analysis and use of vital and health statistics, including persons from governmental and non-governmental institutions (national and local), from the medical profession, from the universities, and from research institutions.

II. *Health Statistics and Related Vital Statistics required by Various Countries according to the Degree of Development of their Health and Administrative Services*

(a) *Areas with Highly Developed Health and Statistical Services*

The Conference generally endorsed the "Principles for a Vital Statistics System" approved by the Economic and Social Council of the United Nations, agreeing with the definitions of vital events contained therein and on their relative importance and priority. From the health point of view marriage and divorce statistics had a somewhat lower priority than they had for legal and social purposes.

While complete registration is essential for a number of legal and administrative purposes, the individual registration of vital events may be usefully supplemented by sampling procedures. In certain circumstances sampling methods might also provide useful supplement or substitute for some of the tabulations relating to vital events, e.g., by providing data earlier than might otherwise be possible, by economizing in the resources needed for full tabulation, or by increasing the validity of the data collected.

Population statistics: the Conference recommended that detailed censuses be carried out at least once every ten years, and also that in intercensal years annual population estimates be made for each country or territory, giving not only global figures but also age and sex distribution.

* *World Health Organization Technical Report Series* 1954, No. 85.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Quinquennial censuses could be envisaged, if necessary on a less detailed basis than decennial censuses. Periodic sample surveys to provide population estimates by sex and age should be considered.

Mortality statistics: Statistics of cause of death remained one of the most important elements of health statistics and in many countries served as the main basis for health policies. The Conference drew attention to the need in some countries for safeguarding the professional secrecy of the certified cause of death, advocated the universal adoption of the international form of medical certificate of cause of death, and recommended tabulation of joint causes based on proper samples of death certificates.

Morbidity statistics: Statistics of cause of death are inadequate in meeting all the needs of health planning and research and need to be supplemented by morbidity statistics, making use of sampling methods where indicated. Even in statistically advanced countries there is still much room for the improvement and development of morbidity statistics. The Conference emphasized the social and economic importance of morbidity statistics apart from their health significance.

Notifications of communicable diseases represented in most countries a very small part of the true morbidity, but they had an important public health significance and should not be neglected. The establishment of panels of medical practitioners undertaking voluntarily to report one type or the other of disease, communicable or otherwise, might often be more effective than a blanket obligation laid on all practitioners to report a large variety of conditions.

Statistics of health institutions, personnel and activities: The Conference recommended that W.H.O. pursue their efforts to collect and publish basic statistics in this field, and to develop uniform definitions and norms applicable in areas having reached various degrees of development.

(b) *Areas with Underdeveloped Health and Statistical Services*

Health statistics: In areas with at least a skeleton health service every effort should be made to maintain full records and to produce summarized figures of cases of diseases treated at hospitals, clinics, etc. In areas where compulsory registration of births and deaths existed constant efforts should be made to improve the completeness of registration and the quality of the details recorded as to causes of death. Where full information cannot be readily obtained of health conditions of populations by fixed health and administrative machinery, medical surveys should be organized, possibly by using mobile medical teams to record total populations and all vital events occurring during the survey period, together with details of causes of death.

When a health programme is to be conducted in an area for the control of a particular health problem the statistics needed for the evaluation of its results should be made an integral part of the plans of such a programme. The designing, collection and analysis of the statistics should be entrusted to a qualified health statistician working in close collaboration at all stages with the technical officers in charge of the programme.

Vital statistics: In some territories compulsory registration cannot be introduced with any chance of success much before the corresponding certificates are required at various stages of an individual's life, e.g. age conditions for education, employment, insurance, and inheritance claims requiring proof of death.

In view of the need for data on the rate of natural growth of the population a sample survey in the absence of or to supplement a census to establish total population and the level of births and deaths is required, and the medical survey referred to above might well be a sub-sample of this larger demographic enquiry.

When resources, e.g. of staff, do not allow the introduction of a comprehensive registration scheme which would otherwise be practicable, the most advantageous course would be to start with a well designed scheme of sample registration districts.

III. *Other Topics Discussed Included:*

(a) *Instruction of Medical Practitioners and Medical Students with Particular Reference to Certification of Cause of Death*

The Conference felt that there was definite value in providing formal instruction for undergraduate medical students in elementary statistical methods, in the value of health statistics, and in the principles and purposes of medical certification of cause of death. A more immediate improvement however was likely to be obtained by efforts directed towards medical practitioners actually concerned with certifying causes of death. Countries should allocate resources necessary for the instruction of medical practitioners to be carried out through any convenient channel of communication (pamphlets, instructions, explanations on death certificates, articles in the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

medical press, group talks, etc.) and by enquiries directed by official agencies to certifying physicians, regarding unsatisfactory entries on death certificates.

(b) *Training of Statistical Personnel*

In view of the difficulties with which a number of countries were confronted in securing training facilities it was considered desirable that the appropriate international agencies prepare simple statistical training material to assist countries to train certain types of statistical personnel. The Conference reviewed the training activities carried out so far by W.H.O. and U.N. and expressed satisfaction with the way in which this programme has been carried out through fellowships, assistance to educational institutions, training centres and seminars.

(c) *Co-operation with Persons concerned with Supplying needed Data*

Different methods whereby this co-operation might be secured were discussed and a number of points were noted, e.g., that "the results of an enquiry should be published as promptly as possible to demonstrate that practical use has been made of the data supplied".

(d) *Rôle of the W.H.O. Centre for Classification of Diseases*

This Centre has been located, since its inception in 1951, in the General Register Office of England and Wales. The Conference reviewed the work of the Centre, noted the valuable contribution it had made in dealing with problems arising in the use of the International Statistical Classification of Diseases, Injuries and Causes of Death, and recommended that the work of the Centre be continued along similar lines.

(e) *Securing Appreciation of the Value of Health Statistics*

The types of activity thought to be most successful in this respect with the medical profession might be summarized as follows:

(i) Education at both undergraduate and post graduate levels
(ii) Publication of articles on biostatistical and biometrical studies in widely read medical journals
(iii) The extending of statistical advice and collaboration in medical research projects.

W. P. D. L.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REPORT OF THE COUNCIL

For the FINANCIAL YEAR *ended December 31st, 1953, and for the* SESSIONAL YEAR *ended June 23rd, 1954, presented at the* ONE HUNDRED AND TWENTIETH ANNUAL GENERAL MEETING *of the* ROYAL STATISTICAL SOCIETY, *held at the London School of Hygiene and Tropical Medicine, W.C.1, on June 23rd, 1954.*

Number of Fellows

AT December 31st, 1953, the number of ordinary Fellows attained a new high level of 2,488, a figure 64 in excess of the previous record reached in 1952. The net gain was, however, the smallest for ten years. During 1953, 165 Fellows were elected or restored to the roll and 101 were lost. While losses were fewer than in either 1951 or 1952, additions were appreciably smaller than for some time.

A slight increase in the number of Fellows during the early months of 1954 brought the total at the end of April to 2,498.

No change took place during 1953 in the number of Honorary Fellows. As in the previous year 7 of these 14 were presidents for the time being of other societies concerned with the advancement of statistical knowledge.

Representatives of corporate bodies or institutions numbered 114 and are included in the figure of 2,488 ordinary Fellows.

	Number of Fellows (excluding Honorary Fellows)		
Calendar Year	*Lost by Death, Withdrawal or Default*	*Elected, or Restored to the Roll*	*On the Roll at December 31st*
1942	69	74	1,079
1943	61	121	1,139
1944	29	159	1,269
1945	29	177	1,417
1946	56	287	1,648
1947	75	263	1,836
1948	96	238	1,978
1949	103	189	2,064
1950	93	222	2,193
1951	114	228	2,307
1952	104	221	2,424
1953	101	165	2,488

Losses by Death

It is with regret that the Council records the loss by death during the year ended April 30th, 1954, of the undermentioned Fellows:

	Date of Election
*Ebbisham of Cobham, The Rt. Hon. Lord, G.B.E., D.L.	1929
Elven, W. W.	1922
Eveleigh, F. W. Anton, F.S.A.A., C.A.(S.A.)	1913
*Forrester, Professor Robert B., M.A., M.Com.	1923
Geoghegan, Basil, M.R.C.S., L.R.C.P.	1950
Jones, Daniel, B.Sc.(Econ.)	1948
Keskar, Y. D., M.A., B.Com.	1936
Morton, Diana Elizabeth Tudway, B.Sc.(Econ.)	1947
*Pownall, Lt.-Col. Sir Assheton, O.B.E., T.D., D.L.	1919
Richardson, Alban Ernest, M.B.E., F.I.M.T.A.	1922
*p*Russell, W. T., D.Sc.	1930
*Southall, Arthur Mackenzie	1921

* Life Fellow. *p* Contributed to *Proceedings*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

W. T. Russell became a Fellow five years after joining the staff of the Medical Research Committee (later the Medical Research Council). In its Statistical Research Unit, under Professor Greenwood, his gifts for teaching and research work found a satisfying outlet at the London School of Hygiene and Tropical Medicine. For the remainder of his life he was statistician to the Institute of Social Medicine in Oxford, carrying out many investigations in the field of vital statistics and writing papers on a variety of medical statistical subjects.

A. M. Southall, who was engaged for many years in statistical work for the United Tanners' Federation, was an energetic member of the Study Section in its pre-war days as the Study Group. He was its chairman for the 1938-39 session, embodying his ideas on the function of the Group in his opening address. In 1930 he was the Group's speaker at a joint meeting with the Institute of Actuaries' Students Society in a debate on the future of the rate of interest and in 1934 he read a paper on the same subject to the Group. This brief record can barely indicate his statistical range. He shared in Group discussions on widely differing topics and by service on the Committee and in many other ways was always ready to further the Group's development.

Honorary Fellows

The Council for the Session 1952–3 at its meeting in May, 1953, paid attention to the question of Honorary Fellowship. The Council recalled that it was almost 20 years since an Honorary Fellow was last elected and felt that in view of the great advances made in many statistical fields since then steps should be taken to extend the Society's list of Honorary Fellows. A special Committee was therefore appointed to consider arrangements for the election of Honorary Fellows and to make representations on matters of policy. The report of this Committee was accepted at the July meeting of the Council and as a result the Council added to its Standing Committees one specifically required to recommend to the Council candidates for election to Honorary Fellowship. This Committee carefully considered several suggestions that had been made and, while mindful of the claims of many statisticians of international reputation, nevertheless felt that the increase in the number of Honorary Fellows should be strictly limited. Recommendation was accordingly made, and accepted by the Council, that the names of 11 statisticians of acknowledged authority should be put forward for election to Honorary Fellowship.

Vice-Presidents

The President appointed as Vice-Presidents of the Society for the Session 1953-54 Professor G. A. Barnard, Mr. E. C. Fieller, Mr. Philip Lyle and Dr. F. Yates.

Meetings of the Society

The Ordinary General Meetings of the Society this Session, as in previous years, have been held in the lecture theatre of the London School of Hygiene and Tropical Medicine, and the Council wishes once more to place on record its indebtedness to the Board of Management and to the Dean of the School for permitting the use of these premises.

The papers read during the Session have been as follows:

1953	
November 18th	BAUER, P. T. Statistics of Statutory Marketing in West Africa, 1939–51.
December 16th	GABOR, D., and GABOR, A. An Essay on the Mathematical Theory of Freedom.
1954	
January 27th	BROWNING, H. E., and SORRELL, A. A. Cinemas and Cinema-going in Great Britain.
February 24th	FARRELL, M. J. Demand for Motor Cars in the United States.
March 24th	CLARK, COLIN G. World Supply and Requirements of Farm Products.
April 28th	GLOVER, K. F., and MILLER, D. N. The Outlines of the Road Goods Transport Industry.
May 19th	DURBIN, J., and STUART, A. Callbacks and Clustering in Sample Surveys: an Experimental Study.

The attendances have varied between 45 and 116, and have thus shown a narrower range than in recent years. The number of Fellows and visitors who spoke at the meetings has varied between

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5 and 12. The Council regrets the difficulty, which has increased in recent Sessions, of securing papers for reading at Ordinary Meetings. Fellows are accordingly invited to offer papers for this purpose more freely than has been the case recently. It may be that the emphasis which during the last year or two has been placed on brevity will encourage those who might otherwise feel that essays of considerable length are required.

The Research Section

Mr. E. C. Fieller was elected Chairman of the Research Section, and Dr. P. Armitage has served for a second year as Honorary Secretary. Other members of the Section's Committee have been: Dr. G. E. P. Box, Mr. J. Durbin, Mr. J. M. Hammersley, Mr. M. J. R. Healy, Dr. N. L. Johnson, Mr. D. V. Lindley, Dr. K. D. Tocher, Dr. S. Vajda, with Dr. D. J. Finney and Professor M. G. Kendall nominated by the Council, and Dr. J. O. Irwin an *ex-officio* member as Editor of Series B of the *Journal*.

The papers read during the Session have been as follows:

1953
November 25th — FOSTER, F. G., and STUART, A. Distribution-free Tests in Time-Series based on the Breaking of Records.

1954
January 20th — (Symposium on Monte Carlo Methods.)
HAMMERSLEY, J. M., and MORTON, K. W. Poor Man's Monte Carlo.
TOCHER, K. D. The Application of Automatic Computers to Sampling Experiments.
March 17th — BARNARD, G. A. Sampling Inspection and Statistical Decisions.
May 12th — (Symposium on Interval Estimation.)
FIELLER, E. C. Some Problems in Interval Estimation.
CREASY, MONICA A. Limits for the Ratio of Means.
DAVID, S. T. Confidence Intervals for Parameters in Markov Autoregressive Schemes.

The Industrial Applications Section

The Section Committee which co-ordinates the functions of the separately organised Local Groups and links them with the Society has consisted of: Mr. D. J. Desmond, Mr. E. C. Fieller, Mr. G. H. Jowett, Miss J. Keen, Mr. Philip Lyle, Mr. A. W. Swan (appointed by the Council); Mr. E. D. van Rest, Mr. N. J. Squirrell, Mr. P. J. Stanley (nominated by the 1952–53 Section Committee); together with the Chairman and Secretary of each of the Local Groups.

The Section Committee elected as officers, Chairman, Mr. N. J. Squirrell; and Honorary Secretary, Mr. P. J. Stanley.

The officers of the Local Groups were:

Group	*Chairman*	*Honorary Secretary*
Birmingham and District	Mr. C. H. Leigh-Dugmore	Mr. K. Mannaberg
Glasgow	Mr. W. A. Bennett	Mr. A. Kirk
Leicester	Mr. K. T. Boyd	Mr. A. Bramley
London	Mr. G. W. Sears	Mr. M. Whyte
Merseyside	Mr. W. J. Jennett	Mr. R. L. Plackett
North-Eastern	Mr. D. Gold	Mr. H. Arnell (part year) Mr. W. J. Ross (part year)
Sheffield	Mr. A. Stafford Beer	Mr. B. A. Maguire
South Wales	Mr. R. B. Rowson	Mr. W. D. Ewan

On December 31st, 1953, the roll of members was as follows (1952 figures are given in brackets):

Local Group	*Fellows*	*Non-Fellows*	*Total*	*Average Attendance 1953–54*
Birmingham	37 (33)	17 (28)	54 (61)	18
Glasgow	9 (5)	52 (49)	61 (54)	18
Leicester	13 (13)	27 (32)	40 (45)	33
London	116 (105)	74 (74)	190 (179)	55
Merseyside	13 (12)	43 (63)	56 (75)	19
North-Eastern	25 (15)	7 (13)	32 (28)	25
Sheffield	22 (21)	44 (47)	66 (68)	21
South Wales	20 (26)	9 (7)	29 (33)	16
Total	255 (230)	273 (313)	528 (543)	

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Fellows who are stated to be members of the Section are those who wish to be attached to a particular Group for the purpose of voting in its elections and being eligible for serving on its Committee.

The accounts of the Section and its Local Groups for the calendar year 1953 (excluding expenditure incurred by the Society in relation to the work of the Section) are summarized below:

Expenditure	£ s. d.	£ s. d.
Birmingham	19 0 7	
Glasgow	45 1 3	
Leicester	12 8 0	
London	24 4 2	
Merseyside	17 19 0	
North Eastern	20 2 5	
Sheffield	18 11 3	
South Wales	13 17 10	
Secretarial expenses	54 11 0	
		225 15 6
Carried forward to 1954		59 0 6
		£284 16 0

Income	£ s. d.
Brought forward from 1952	40 2 6
Grants from Council	240 0 0
Sundry income	4 13 6
	£284 16 0

A Conference, organized by the Industrial Applications Section, was held by the Society at the College of Aeronautics, Cranfield, Bedfordshire, from September 25th to 28th, 1953. The Organizing Committee consisted of: Mr. K. T. Boyd, Miss Joan Keen, Mr. E. D. van Rest, and Mr. P. J. Stanley. There were 145 people in residence and some 155 attended the meetings. The Conference was opened by Sir Victor Goddard, K.C.B., C.B.E., M.A., Principal of the College, who welcomed members to Cranfield.

The subjects discussed, and the principal speakers were:

Management and the Statistician—L. H. C. Tippett.
The Analysis of a Complex Experiment—G. W. Sears and G. P. Davies.
Production Control of Mixed Output on Varied Machinery—A. Stafford Beer.
The Solution of Normal Equations—E. C. Fieller.
Quality Control with Samples of One—D. J. Desmond.
The Comparison of Averages for Industrial Time Series—G. H. Jowett.
Labour Turnover—Joan Keen.
The Use of Nomograms in Statistics—Philip Lyle.
The Extraction of Data from Past Records—W. A. Pridmore.
The Analysis of Machine Stoppage Rates—D. R. Cox.
Some Experiments involving Subjective Judgment—W. N. Jessop.
Teaching Statistics for Industry—G. A. Barnard.

The programme also included a tour of the laboratories at the College of Aeronautics and a visit to the Stewartby works of the London Brick Company Ltd. The Council thanks the Principal and Staff of the College of Aeronautics and the London Brick Company Ltd. for the hospitality extended to members.

Fifty-four meetings listed below, were held by Local Groups: 7 each in Birmingham, Glasgow, Leicester, Liverpool, London and Newcastle-upon-Tyne; 6 in Sheffield; 3 in Newport; 2 in Cardiff; 1 in Crumlin.

Birmingham and District Group

1953

October 7th	Shorter Methods of Analysis—C. H. Leigh-Dugmore.
November 4th	Inspection in Industry—A. Heward, S. W. Nixon and E. D. van Rest.
December 9th	A Regression Control Chart in Personnel Selection—F. Sandon.

1954

January 6th	Amount of Experimentation—H. D. Rees.
February 3rd	Constructing Criminological Prediction Tables—L. T. Wilkins.
March 3rd	New Light on the Analysis of Industrial Time Series—G. H. Jowett.
April 7th	Weights and Measures—D. J. Desmond.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Glasgow Group

1953	
October 5th	The Scope of Statistics in Industry—W. A. Bennett.
November 2nd	Measurement of Consumer Demand—C. E. V. Leser.
December 7th	Statistics in Operating and Planning Telephone Exchanges—J. Oliver and M. Harrison.
1954	
January 11th	Statistical Quality Control is not applicable to Heavy Industry—J. B. M. Palmer and A. Kirk.
February 1st	Forecasting Sales—Joan Keen.
March 1st	An Aspect of the Bread Weight Problem—W. Anderson.
April 5th	Public Health Statistics—P. L. McKinlay.

Leicester Group

1953	
October 8th	The Control of Quality in the United States—E. D. van Rest.
November 26th	(Joint Meeting with Birmingham Group) Training the Statistician for the Needs of Industry—B. H. P. Dudding and M. J. Moroney.
December 9th	Statistical Methods in Heavy Engineering—H. C. Hall.
1954	
February 4th	Non-Parametric Tests, Old and New—G. A. Barnard.
February 25th	Productivity Studies in the Cotton Industry—L. H. C. Tippett.
March 25th	Statistical Approach to Profit Forecasting—C. C. Neville.
April 29th	Annual General Meeting.

London Group

1953	
August 26th	Visit to G.E.C. Works and Research Laboratories, Perivale and Wembley.
October 2nd	Washing Up and Statistics—C. Pugh.
November 6th	Statistics and the Accountant—C. E. Sutton.
December 4th	Non-Parametric Tests, Old and New—G. A. Barnard.
February 5th	Statistical Approach to Problems of Congestion in Industry—D. R. Cox.
March 5th	Sales Statistics—Joan Keen.
April 2nd	Multivariate Analysis—J. Wishart.
May 7th	Questions to a Panel consisting of W. R. Buckland, Philip Lyle, K. D. Tocher, E. D. van Rest.

Merseyside Group

1953	
October 6th	The Sampling of Continuous Production Flow—G. H. Jowett.
November 3rd	Statistical Methods and Bio-Assay—R. A. Taggart.
December 1st	Sensory Tests in Experimentation—J. R. Williams.
1954	
January 5th	Statistical Methods in the Development of Chemical Processes—D. R. Read.
February 2nd	Some Newer Methods of Analysis applied to Market Research Data—L. T. Wilkins.
March 5th	Congestion Problems in Industry—J. Murdoch.
April 2nd	Questions to a Panel consisting of Miss J. Keen, Mr. E. F. Livesey, Mr. R. L. Plackett, Mr. L. H. C. Tippett.

North-Eastern Group

1953	
October 14th	Applied Sampling—D. Newman.
November 11th	Analysis of Labour Turnover—Joan Keen.
December 9th	Electronic Computers—M. T. Vickers.
1954	
January 12th	Machine Utilization—M. J. Moroney.
February 10th	Sampling of Airborne Dust in Coal Mines—B. A. Maguire.
March 10th	Linear Regression Analysis—D. A. Evans.
April 21st	Sensory Tests in Industrial Research—K. R. Williams.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Sheffield Group

1953

October 29th — Implications of Recent American Investigations into Work Measurement—M. J. Moroney.

November 26th — Experiences in Forecasting Human Behaviour—L. T. Wilkins.

1954

January 28th — Quality Control as Practised in the U.S.A.—E. D. van Rest.

February 25th — Use of Edge-punched Cards in Statistical Computation—D. H. Ward.

March 25th — Robust Tests—G. E. P. Box.

April 29th — Discussion: Design of Experiments—D. J. Desmond.

South Wales Group

1953

October 10th — Washing Up and Statistics—C. Pugh.

November 19th — Industrial Application of Time Series Theory—G. H. Jowett.

December 3rd — The Work of the Medical Research Council's Pneumoconiosis Research Unit—P. D. Oldham.

1954

January 27th — Non-Parametric Tests, Old and New—G. A. Barnard.

February 24th — Open Discussion Meeting.

April 9th — Multiple Regression Using an Electronic Computer—A. M. Lee and A. M. Whitehouse.

The Council again records its thanks to the Electric Lamp Manufacturers' Association and the South Wales Electricity Board for providing accommodation for meetings in London and Newport respectively.

The Study Section

The members of the Section Committee during the session have been: Miss S. V. Cunliffe (Chairman), Mr. R. J. Finlayson (Honorary Secretary), Mr. A. Bothwell, Mr. M. P. Curwen (Honorary Secretary of the Study Circle on Medical Statistics), Mr. K. F. Glover, Mr. H. C. Mackenzie (Chairman of the Bristol Group), Mr. J. I. Mason, Mr. C. A. Moser, Dr. C. C. Nuttall, and Mr. L. T. Wilkins. Miss Cunliffe and Mr. Wilkins were the Council's representatives.

The following general meetings were held in London:

1953

October 27th — Some Problems in Questionnaire Design—B. P. Emmett.

November 19th — Smoking and Cancer of the Lung—R. Doll. (Joint Meeting with the Study Circle on Medical Statistics.)

December 9th — Monte Carlo Methods—I. J. Good.

1954

January 13th — Personnel Management and Statistics—B. Ungerson.

February 10th — Predicting Success after Borstal Training—L. T. Wilkins.

March 10th — The Economist in Business—E. F. Schumacher.

April 14th — Coding Procedures for Interview Data—Amelia Harris.

May 12th — Post Budget Outlook for 1954, a Symposium—J. R. N. Stone, F. W. Paish and J. Ryan.

June 9th — Annual General Meeting followed by A Critical Review of Recent Literature on Statistical Applications—C. A. Moser, A. Bothwell, B. B. Swann.

These meetings have in general been well attended, with between 40 and 50 people present at most of them.

The Bristol Group has held six meetings at which the following subjects have been discussed:

1953

October 15th — An Introduction to Information Theory—D. M. McKay, D. Gabor and G. Herdan.

November 19th — An Application of Information Theory in Experimental Psychology—J. C. Brown.

December 17th — Recent Developments in International Statistics—H. Campion.

1954

January 21st — Some Aspects of Statistics in Experimental Horticulture—G. M. Clarke.

February 18th — Farm Accounts as a Source of Statistics—C. V. Dawe.

June 10th — An Application of Sequential Analysis to Account Data—G. Herdan.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The attendance has varied from 12 to 42.

Mr. H. C. Mackenzie has been Chairman of the Group for the session, Mr. R. W. Gloyne served as Honorary Secretary until his resignation in November, when his place was taken by Mr. F. J. Dennis. Other members of the Committee were Mr. D. A. Clark and Dr. G. Herdan. Mr. Dennis resigned on leaving the district in February.

The Committee of The Study Circle on Medical Statistics for the session has consisted of: Mr. B. Benjamin (Chairman), Mr. M. P. Curwen (Honorary Secretary), Mr. F. D. Bushell, Dr. M. A. Heasman, Mr. D. M. Iles, and Mr. L. T. Wilkins.

The detailed regulations for the conduct of the Study Circle which were approved by the Council on May 14th, 1953, were published in the *Journal* Series A, Part IV, 1953.

The following meetings have been held during the session:

1953	
September 29th	Follow-up Problems in Tuberculosis—V. F. Springett.
October 27th	A Discussion on the Reports of the Working Parties set up to examine the following subjects: Measures of Morbidity in the Field of Public Health. Statistical Aspects of Disease Classification.
November 19th	Smoking and Cancer of the Lung—R. Doll. (Joint Meeting with the Study Section.)
1954	
January 26th	Bio-assay—D. J. Finney.
February 23rd	Medical Statistics in the Services, a Symposium—J. M. Holford (Admiralty), S. Rosenbaum (War Office), J. D. Tonkinson (Air Ministry).
March 30th	Queueing for Medical Care—N. T. J. Bailey.
April 27th	Discussion of the Report of the Working Party set up to examine the Assessment of the Need for Clinical Services.
May 25th	Annual General Meeting followed by a debate on the resolution "This House welcomes the Growing Influence of Statistics in all Branches of Medicine". Proposer: R. J. Asher, F.R.C.P. Opposer: R. S. Murley, F.R.C.S.

Attendances have ranged from 28 to 46.

By kind permission of the Dean these meetings (with the exception of the joint meeting with the Study Section) were held at the Westminster Hospital Medical School.

The Council again expresses its indebtedness to the Electric Lamp Manufacturers' Association, the University of Bristol and the Westminster Hospital Medical School for so kindly providing accommodation for the meetings of the Section.

Award of the Guy Medal in Silver

On the recommendation of the Executive Committee, the Council cordially approved the award of the Guy Medal in Silver to Mr. L. H. C. Tippett. His work on the measurement of productivity in the cotton industry has won outstanding recognition and is reflected in papers he has presented to the Society in recent years. Fellows will recall his paper on "Some Applications of Statistical Methods to the Study of Variation of Quality in the Production of Cotton Yarn" (1935) as well as his study in "Industrial Efficiency with Special Reference to the Cotton Industry" (1947) and (presented jointly with Mr. P. D. Vincent) "Statistical Investigations of Labour Productivity in Cotton Spinning" (1953). The Council is mindful also of his work as Editor of *Applied Statistics*. It is very largely owing to Mr. Tippett's energy and critical appreciation of statistical material that *Applied Statistics* is so ably fulfilling its purpose. The Council is confident that Fellows will readily endorse its decision to make this award.

Professor A. Bradford Hill, C.B.E., F.R.S.

It is fitting that the Council should extend its warm congratulations to Professor A. Bradford Hill on his election in March as a Fellow of The Royal Society. It was at the last Annual General Meeting that he was awarded the Guy medal in Gold—the highest distinction in the power of this Society to give. The Council feels that his recent and further honour serves to add point to the tribute to his work which the Society has itself already made.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Society's Examinations

Twenty-seven candidates for all or part of the Certificate and three for the Diploma presented themselves for the examinations held on March 24th, 25th and 26th, 1954.

The following Fellows have been awarded the Certificate of the Society:

Baird, Cecil Gardner.
Borland, William Cunningham Wright.
Friend, John Kimball.
Gales, Kathleen Emily.
Goodier, William Derek.
Gratwick, John.
Harrington, Geoffrey.
Jones, Hugh John McNab.
Lea, Allan Joseph.
Lewis, Peter Owen.
McAllister, Denis Walter.
Scarr, John Robert.
Swan, David McDonald.
White, Oliver Morrow.

The following Fellows have been awarded the Diploma of the Society, the specialized field on which one section of the examination was based being given in brackets:

Hall, Richard Sutherland (Psychology and education).
Rowell, John Gerrard (Biological and agricultural research).
Wilson, William A. (Medical statistics).

The Diploma examination was held overseas for the first time, in Johannesburg, S. Africa, and in Kampala, Uganda. The Certificate examination was held in Salisbury, S. Rhodesia, and Accra, Gold Coast. The Council is indebted to Mr. J. E. Kerrich (Johannesburg), Mr. J. R. H. Shaul (S. Rhodesia), Mr. G. C. Billington (Accra) and Professor Alexander Galloway (Dean of the Faculty of Medicine, Makerere College, Kampala) for accepting responsibility for the necessary local arrangements.

The Council again records its thanks to the London School of Hygiene and Tropical Medicine for allowing the examinations to be held in its Department of Medical Statistics and Epidemiology, to those Fellows who acted as invigilators, and to the Examinations Committee and others who have helped the Committee in its work. The Committee has consisted of: Mr. E. C. Fieller (Chairman), Professor R. G. D. Allen, Dr. P. Armitage, Professor G. A. Barnard, Mr. B. Benjamin, Mr. W. J. Corlett, Mr. J. Durbin, Dr. D. J. Finney, Mr. M. J. R. Healy, Mr. F. A. A. Menzler, Mr. D. Newman, Professor E. S. Pearson, and Dr. J. W. Whitfield.

The Journals

For the second year running, the four parts of the *Journal* Series A were published in the calendar year, during which two parts of the *Journal* Series B were also published. Part II of the 1953 volume was issued in February, 1954, and it is hoped that both parts of the 1954 volume will appear during the present calendar year. The Council acknowledges its appreciation of the continued services of Dr. J. O. Irwin, the Chief Editor of Series B and of the help given by the Editorial Panel—Mr. F. J. Anscombe, Dr. P. Armitage, Professor G. A. Barnard, Professor M. S. Bartlett, Dr. D. R. Cox, Dr. H. E. Daniels, Dr. O. L. Davies, Mr. E. C. Fieller, Dr. H. O. Hartley, Mr. D. G. Kendall, Professor M. G. Kendall, Mr. R. L. Plackett, Dr. C. A. B. Smith, Mr. J. R. N. Stone, Dr. K. D. Tocher, Dr. F. Yates.

In the last Annual Report, reference was made to the necessity of curbing the tendency for the *Journal*, Series A, to increase in size. The success of these efforts is reflected in a reduction of over 20 per cent. in the number of pages—from 619 in 1952 to 483 in 1953. The Editors are grateful for the co-operation given by readers of papers and other contributors in achieving this welcome and material economy. There are, however, signs that the *Journal* for 1954 may be larger than that for 1953. The Editors will do their utmost to resist this tendency and again urge writers of papers, articles and reviews to exercise the utmost economy in the expression of their thoughts.

During 1953 there were published six further articles on the sources and nature of the statistics of the United Kingdom, under the direction of Professor Kendall. Three more articles are in the press and others in course of preparation. The volume containing the first 20 papers published by Messrs. Oliver and Boyd continues to command a steady sale. About 300 copies were sold last year with a resulting profit of about £180. This means that at the current rate of sale,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the cost of publication will have been completely met by the end of 1955. The Council has authorized the publication of a second volume to complete the series.

Mr. Tippett, the Editor of *Applied Statistics*, reports that the editorial policy originally envisaged was followed during 1953 for Volume II. When the last part was sent to press there was no "back log" of accepted articles awaiting publication. There were 1,402 subscribers (including 490 Fellows) as against 1,495 for Volume I. Some drop in the number of subscribers is not surprising, but it is reasonable to hope that the number will henceforth be maintained or will increase somewhat. The profit on the second volume was £145 as against a loss of £330 on the first.

The costs of launching the journal fell on the first volume and the profit of £145 more nearly represents the result of a normal year's working under existing conditions. The standard number of pages in each part has been 64, although this number has at times been exceeded for special reasons. This is too small a size having regard to the wide range of interests of the readers, and the Council has authorized an increase to an average of 72 pages per part provided sufficient suitable material comes forward for publication. Altogether, *Applied Statistics* is growing in strength but it still needs the active support of those who believe in it and wish it to prosper.

The *Applied Statistics* Committee has consisted of: Mr. L. H. C. Tippett (Editor), Dr. D. G. Beech, Dr. O. L. Davies, Mr. R. F. Fowler, Dr. J. O. Irwin, Mr. G. H. Jowett, Mr. Philip Lyle, Mr. C. A. Moser, Dr. C. C. Nuttall, Mr. E. D. van Rest, Mr. E. Shankleman, and Mr. L. T. Wilkins.

The Library

The services given to Fellows during 1953 can be summarized statistically as follows:

	1951	1952	1953
Number of Fellows who made requests to borrow books	347	391	343
Number of applications made	1,210	1,423	1,319
Number of volumes borrowed	2,112	2,419	2,110
Number of volumes "on loan" (unavailable) at time of request	250	195	185
Number of volumes not in the Library at time of request	190	241	174
Total number of volumes asked for	2,552	2,855	2,469
Non-serial works added to the Library	529	594	516

In 1953–54 the Committee has had to face the formidable problem of moving the Library to the new premises, a task which happily occurs at very infrequent intervals. This presented real difficulties because the accommodation at Bentinck Street was some 30 per cent. less than at Portugal Street. Although it was clear that in a library containing some 90,000 volumes, a good deal of pruning would be possible, it was early realized that storage space elsewhere than at Bentinck Street would be necessary. This was not easy to find, but the kindness of the London School of Hygiene and the Imperial College in offering accommodation ultimately provided a solution. The Council desires to put on record its gratitude to the authorities at these two schools of the University of London, and in particular to Professor Bradford Hill and Professor Barnard, for their generous help. The arrangements associated with the move, during which the Library was closed for a period of seven months, were much facilitated by a close liaison between the Library Committee and the House Committee.

Finally the Council acknowledges with great appreciation the services of the Librarian and his staff, who had to carry out the arrangements and strike a balance between the desire for speed in vacating the premises at Portugal Street and efficiency in the arrangement of the Library in its new home at Bentinck Street. Miss Clarke's services were particularly valuable and the Council, while greatly regretting her departure last January, wishes her every success in her new work.

Housing

After many legal and architectural problems had been overcome the Society's new premises at 21, Bentinck Street, W.1, were at last ready early in 1954 for the move from Portugal Street to take place. The office, therefore, changed its address on January 15th. The transfer of that

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

part of the Library which could be accommodated at Bentinck Street had already begun and was still to take many weeks to complete. Some of the difficulties associated with moving the Library are mentioned in the paragraph dealing specifically with the Library.

The Council acknowledges its gratitude to the office and library staff not only for another year's devoted service but also for the invaluable help so readily given in the move. The Council's thanks are also due to the House Committee which has consisted of: Mr. Philip Lyle (Chairman), The President, Miss I. Douglas, Mr. R. F. Fowler, Professor A. Bradford Hill, Dr. J. O. Irwin, and Miss U. M. Croker.

There have been innumerable problems of policy, principle and detail to solve, and Fellows who have visited or used the new premises will realize how successfully the House Committee has dealt with them.

The Council is also anxious to place on record its deep appreciation of the services rendered by its architect, Mr. Ian Forbes, of Messrs. Forbes and Tate. Many of the attractive features of 21, Bentinck Street and the less obvious features of internal reconstruction depended on Mr. Forbes's sympathetic and understanding advice which he was always willing to place at the disposal of the House Committee.

The Council hopes that the Society's new premises will for many years justify the great amount of thought and care which has been devoted to the question of housing over the past two years.

Finance

Abstracts of the Honorary Treasurer's Accounts, viz., the Statement of Income and Expenditure for the year 1953 and the Balance Sheet as at December 31st, 1953, together with the Auditor's Report thereon, are contained in Appendices B, C and D.

Total income, excluding Life Composition Fees received during the year, rose from £13,505 in 1952 to £15,950 in 1953. Annual subscriptions increased by £257 and sales of *Journal* B by £170. The fall in sales of *Journal* A was due entirely to the fact that 4 issues were published in 1953 compared with 5 issues in 1952. Average sales per issue were however greater in 1953. Expenditure chargeable to the Rockefeller Foundation Grant amounted to £2,905 and this sum has been included in Income for the year. Interest received on the 3½ per cent. British Electricity Stock held in the Benefaction Fund amounted to £597.

Following the grants made in recent years the Royal Society made a further grant of £500. The Council records its deep appreciation of this further generous help.

Total Expenditure rose slightly from £13,835 in 1952 to £14,113 in 1953. There was a substantial reduction in the publication and distribution costs of the two Journals from £7,902 to £5,464. The average cost per issue of the 4 numbers of *Journal* A published in 1953 was £935 compared with an average cost of the five numbers published in 1952 of £1,092. This was the result of steps taken by the Council last year, with the co-operation of Fellows, to make more concise the contributions published in the Journals. The costs of publishing and distributing *Journal* B fell from £2,441 to £1,723 (£1,220 to £861 per issue). As a result the excess of expenditure on *Journal* A over receipts from sales declined from £2,094 to £979. For *Journal* B the excess of expenditure of £764 in 1952 was replaced by an excess of receipts from sales of £121 in 1953. This was partly due to special sales of complete sets made possible by the reprinting in 1952 of Vol. II (1935). For *Journal* A and B taken together there was an excess of expenditure over receipts of £858. There was also a fall in expenditure on stationery and miscellaneous printing. There were increases of £225 in rent, £164 in house expenses, £224 in salaries and wages, £1,516 in office and library equipment, £213 for amortization of leasehold premises and £243 for costs in connection with removal to Bentinck Street. The net loss to date on *Applied Statistics* after allowing for certain costs included in the 1952 accounts amounted to £143 and this sum has been charged to expenditure for 1953.

As a result of the year's operations there was a surplus of £1,837. After allowing for the deficits in 1950, 1951 and 1952 amounting in total to £914 there remains £923. It must be remembered that there will be further exceptional expenditure to be met in 1954.

Composition Fees received during the year declined from £555 in 1952 to £260. After allowing for the fees of compounders who died during the year or were presumed to have died in previous years, the Composition Fee Fund, maintained at the total of Composition Fees received from Fellows still living, amounted to £7,583 at the end of the year.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Capital expenditure incurred during 1953 in connection with the structural alterations to the Society's new premises amounted to £5,665. The value at cost of the leasehold premises, after deducting amortization to December 31st, 1953, was £20,193. At the end of the year £425 was added to the Sinking Fund Investment, which stands at £646. The Benefaction Fund Investment, reflecting the increased capital expenditure incurred during the year, has been reduced from £15,249 to £9,855 represented by £11,312 nominal of 3½ per cent. British Electricity Stock 1976–79.

The Council and Officers

Sir Ronald Fisher, F.R.S., completed his second consecutive year of office at the end of the Session 1953–54 and is therefore not eligible for re-election in that capacity. The Council is glad to acknowledge its indebtedness to the retiring President for the distinction he has brought to this office. It was with great satisfaction that the Council learnt of Lord Piercy's willingness to be nominated to succeed Sir Ronald Fisher.

The Council records its appreciation of the services rendered by those of its ordinary members who now retire—Dr. W. R. Buckland, Mr. E. C. Fieller, Mr. G. H. Jowett, Professor M. G. Kendall, Mr. D. Newman, and Mr. L. G. K. Starke. After observing the requirements of the Bye-laws and having considered the suggestions received, the Council recommended that the six vacancies for ordinary members be filled by the election of Dr. P. Armitage, Professor M. S. Bartlett, Mr. B. Benjamin, Mr. W. F. Searle, Mr. J. Stafford and Mr. L. H. C. Tippett. No alternative proposals were received and the Fellows named below will be announced at the Annual General Meeting on June 23rd, 1954, as having been elected President, other officers, and other members of Council for the Session 1954-55.

President

Lord Piercy of Burford,

Council

R. G. D. Allen.
F. J. Anscombe.
*P. Armitage.
G. A. Barnard.
**M. S. Bartlett.
**B. Benjamin.
H. Campion.
D. G. Champernowne.
Stella V. Cunliffe.
D. J. Finney.
R. Glenday.
J. O. Irwin.
Joan E. Keen.
W. P. D. Logan.
Sir George Maddex.
F. A. A. Menzler.
C. A. Moser.
E. D. van Rest.
J. Ryan.
*W. F. Searle.
*J. Stafford.
A. W. Swan.
**L. H. C. Tippett.
L. T. Wilkins.
J. Wishart.
F. Yates.

Honorary Treasurer

R. F. Fowler.

Honorary Secretaries

R. F. George. Philip Lyle. Iris Douglas.

On behalf of the Council,

R. A. Fisher,

President.

R. F. George
Philip Lyle
Iris Douglas
} *Honorary Secretaries.*

Those marked ** were not Members of Council during the preceding session; those marked * have never served on the Council.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPENDIX A

From June, 1953 to May, 1954 inclusive, the candidates named below were elected Fellows of the Society:

Alexander, Geoffrey Newman.
Alexander, Marcus Falk.
Aneuryn-Evans, Gwyn Barcham.
Anrep, John.
Artingstall, Ronald William.
Ashford, John Robert.
Ashton, Boyd.
Avis, Peter Richard.

Balmforth, Jack.
Bamford, Thomas.
Barron, Cyril John.
Basu, Sunil Kumar.
Bates, Maurice Ernest.
Bell, Joseph Roger.
Bell, Richard Marmaduke
Berman, Laurence Sam.
Brands, John.
Bregman, Barbara Beata Hialina.
Briggs, Frank Elliott Ashworth.
Brontë-Hearne, Patrick Branwell.
Bullock, Ronald.
Bulmer, Michael George.
Burke, Stanley Frederick.

Cameron, Donald.
Chambers, Harry William David.
Choudhury, T.
Clarke, Geoffrey Mallin.
Clay, John Lloyd.
Cockerham, Leslie Stead.
Cooke, Dennis.
Cooper, Raymond Douglas.
Corlett, Thomas.
Coutie, George Angus.
Critchley, John.
Crouch, Patricia Maud.
Cruise, Sydney Elvin.

Daisley, Peter Anthony.
Das, Bisweswar.
David, Herbert Aron.
Davies, Alan Lindsay.
Davison, John Frederick.
Dean, Geoffrey Alan.
Dickinson, Roger.
Donelan, Conor John.
Ducros, Pierre Louis Emile.

Ećimović, P. Juraj.
Edwards, John Hilton.
Ellison, Jean Daphne.
Evans, Rees Evan.

Farrag, Abdelmegid Moustafa.
Fereday, Mary Joy.
Ferres, Helen Millecent.
Forsyth, Finlay Gow.
Foster, Frederic Gordon.
Friend, John Kimball.
Fry, Ronald Ernest.
Fryer, Richard William.

Gales, Kathleen Emily.
Ghosh, Santa.
Gibson, Robert Amos.
Gluss, Brian.
Goldsbrough, Mary Jocelyn.
Goodger, Geoffrey Harry.
Goodier, William Derek.
Gouri, Gangadhar Shrishailappa.
Green, Victor Mark.
Greenhalgh, Peter Alan.
Gribbin, John Denys.

Hajnal-Konyi, John.
Hampson, Arthur Eric.
Handa, Narindra Nath.
Harley, Betty Irene.
Harrington, Geoffrey.
Harris, Malcolm.
Hayter, Jack Henry.
Healing, Robert Arthur.
Hill, George Henry
Hornby, Harold.
Horsnell, Gareth.
Hughes, Helen.
Hughes, Robert Elfyn.
Humphrays, Henry.

James, Antony Neville.
Jones, David Wyn.
Jones, Eric.
Jones, Evan John Clement.
Jouvin, Jacqueline.
Jowett, Eric.

Kastell, Richard Herbert.
Kelly, Thomas William.
Khaled, Mohammed.
Kipling, Charlotte.
Knox, Bryce Harry.
Krotki, Karol Jozef.

Laha, Arumansu Kumar.
Lamberth, Denis Leslie.
Lauria, John Noel.
Lea, Allan Joseph.
Limb, Kenneth.
Lipton, Stephen.
Livingstone, David Willmott.
Loftus, Peter.
Luery, Laurence Henry.

Mahmoud, Moharram Wahby.
Marriner, Richard Stanley.
Mathur, Umrao Bahadur.
Maxwell, Albert Ernest.
Millband, Laurence.
Misra, Avadh Behari.
Misselbrook, Bertram Desmond.
Mohan, Chandra.
Moore, Philip.
Morrison, Lord.
Moul, Gillian Mary.
Mountford, Edward Thomas.
Mountford, Malcolm David.
Munden, John Major.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Newman, John Allen Sandys.
Newman, Philip Charles.
Nucho, Hanna Nicola.

Olver, John Richard Denis.
Osborne, Ernest Leslie.
Oswald, Robert Raine.
Outlaw, John Eric.
Owen, Eleanor Marjorie.

Padley, Kenneth Charles.
Peaker, Gilbert F.
Pirow, Peter Cluver.
Pollitt, Harry Wilfred Wallace.
Pomeroy, Charles Duncan.
Poonai, Premsukh.
Preece, Arthur Edward.
Preger, Jacob.
Pretty, James Elliott.

Rees, Douglas Howell Smith.
Richardson, Max.
Ridley, George Galloway.
Rigden, Ronald James.
Roberts, Paul.
Rowell, John Gerrard.
Russell, Alan Arthur.
Rutledge, Robert Whitaker.

Sarhan, Ahmed Ebada Hossein.
Scarr, John Robert.
Schattmann, Stephan
Seager, John Sidney.
de Silva, Kodikara.
Simmonds, John Maurice.
Singh, Shamsher.
Smith-Gavine, Sydney Anstey Neil.
Springall, Geoffrey John.
Stamler, Vivienne Honor.
Stokes, Geoffrey Wilfred.
Stott, Walter Trevor.
Sumner, Anthony.
Sundrum, Ramaswamy Meenatchi.
Sutherland, John.

Thomas, Bernard Arthur Morgan.
Thomas, David Glyn.
Thompson, Frank Pilling.
Thompson, William Whinham.
Truesdale, John Percy Lyon.

Vagholkar, Manohar Khanderao.

Wale, Pamela Mary.
Walker, Beatrice Edith May.
Warrington, Anthony.
Waugh, William Anthony O'Neill.
West, Thomas Judge.
Wetherill, George Barrie.
White, Oliver Morrow.
Wicken, Geoffrey William.
Wise, John.
Woyda, Hans Gerhard.

Yates, Frederick Ronald.

Corporate Representatives

Briers, Phyllis Mary	*representing*	The National Coal Board.
ap Gwynn, Arthur,	*representing*	The Library of the University College of Wales.
Maynard, Thomas Charles,	*representing*	The Westminster Bank Ltd.
Meaney, Patrick Michael,	*representing*	The Joint Clothing Council Ltd.
Perk Vlaanderen, L.,	*representing*	The International Rubber Study Group.
Rix, Stuart Millward,	*representing*	The British Electricity Authority.
Wykeman, Peter Tom Ulrich,	*representing*	The British Iron & Steel Federation.
Wynne Willson, John Percival,	*representing*	The Imperial Tobacco Co. Ltd.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPEN

STATEMENT OF INCOME AND EXPENDITURE

EXPENDITURE

1952			1953	
£	£		£	£
380		Rent—Portugal Street	380	
65		Ground rent and tax—Bentinck Street	290	
				670
	445			563
	399	House expenses		
		Salaries and wages (including contribution to staff superannuation		
	2,638	scheme)		2,862
	250	Pension		250
	30	Insurance		42
	77	Office and Library equipment		1,593
	135	Postage and telephone		116
	610	Stationery and miscellaneous printing		456
		Publication and distribution expenses:		
		Journal, Series A (General) and reprints	3,741	
5,461		Journal, Series B (Methodological) and reprints	1,723	
2,441				5,464
	7,902			143
	—	"Applied Statistics" – Loss to date		
		Library:		
		Books	260	
255		Binding	200	
182				460
	437			175
	206	General Meetings—ordinary and annual		32
	24	Council and committee travelling expenses		
		Expenses of sections:		
		Research	45	
37		Industrial Applications	246	
143		Study	28	
29				319
	209			60
	8	Guy Medals		
		Examination expenses:		
		Printing, stationery, postage etc.	84	
83		Examiners' fees	59	
60				143
	143			37
	37	Auditor's fee (1952)		60
	73	Miscellaneous expenses		425
	212	Amortisation of leasehold premises		243
	—	Costs of removal to new premises		1,837
	—	Surplus carried to Accumulated Fund		
				15,950
	13,835			260
	555	Amount carried to Life Composition Fee Fund		
	£14,390			£16,210

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

DIX B

FOR THE YEAR ENDED 31ST DECEMBER, 1953

INCOME

1952 £	1952 £		1953 £	1953 £
		Annual subscriptions:		
5,886		Fellowship	6,120	
3		Research Section	10	
78		Industrial Applications Section	99	
15		Study Section...	10	
	5,982			6,239
	50	Contribution from Royal Economic Society		50
	639	Dividends and interest (gross)		628
		Sales of Journal:		
3,367		Journal, Series A (General) and reprints	2,762	
1,674		Journal, Series B (Methodological) and reprints	1,844	
	5,041			4,606
	45	Sales of other publications		33
		Examination receipts:		
123		Fees	95	
17		Sale of papers	11	
	140			106
	400	Grant from Royal Society		500
	866	Grant from Rockefeller Foundation—expenditure appropriated thereto		2,905
	35	Surplus from Conferences		152
	105	Transfer from Life Composition Fee Fund, being fees of compounders known to have died during year and of those presumed to have died in previous years		134
	202	1950 Benefaction Fund—interest on investment		597
	13,505			15,950
	330	*Deficit carried to Accumulated Fund*		—
	13,835			15,950
	555	Life Composition Fees received during year		260
	£14,390			£16,210

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPEN

BALANCE SHEET AT

FUNDS AND LIABILITIES

1952 £	£		1953 £	£
		Accumulated Fund:		
7,135		Balance at 31st December, 1952	6,805	
—		*Add:* Balance per Statement of Income and Expenditure ...	1,837	
330		*Deduct: Balance per Statement of Income and Expenditure*	—	
	6,805			8,642
		Life Composition Fee Fund:		
7,007		Balance at 31st December, 1952	7,457	
555		*Add:* Life Composition Fees received during year	260	
7,562			7,717	
105		*Less:* Transfer to Statement of Income and Expenditure of fees of compounders known to have died during year, and of those presumed to have died in previous years	134	
	7,457			7,583
		Building Fund (per contra):		
1,380		Balance at 31st December, 1952	1,432	
52		*Add:* Income for year	54	
	1,432			1,486
		1950 Benefaction Fund (per contra):		
	30,971	Balance at 31st December, 1952		30,971
		Liabilities and Income held in suspense:		
2,767		Sundry Creditors	5,774	
1,404		Amounts received in advance	1,458	
	4,171			7,232
		Grant from Rockefeller Foundation:		
1,069		Balance as at 31st December, 1952	203	
—		Amounts received during year	3,587	
			3,790	
866		*Less:* Expenditure appropriated thereto	2,905	
	203			885
	51,039			56,799
		Frances Wood Memorial Fund (per contra):		
544		Balance at 31st December, 1952	566	
22		*Add:* Income for year	22	
	566			588
	£51,605			£57,387

REPORT OF

I have examined the above balance sheet and annexed statement of income and expenditure December, 1953, and of its income and expenditure for the year ended on that date according to

5, London Wall Buildings,
London, E.C.2.
2nd June, 1954.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

DIX C

31ST DECEMBER, 1953

ASSETS

1952 £	£		1953 £	£
15,157		*Investments*, per schedule attached ... ... (Market Value, 31/12/52 £15,265, 31/12/53 £21,426)		20,118
1,432		*Building Fund:* Investment, per schedule attached ... ... (Market Value, 31/12/52 £1,203, 31/12/53 £1,365)		1,486
		1950 Benefaction Fund: Leasehold Premises:		
15,174		At cost	20,839	
212		*Less* Amortisation to 31st December, 1953	646	
14,962			20,193	
212		Sinking Fund Investment, per schedule attached (Market Value, 31/12/52 £212, 31/12/53 £657)	646	
15,174				20,839
225		Furniture at cost		225
15,249		Investment, per schedule attached ... ... (Market Value, 31/12/52 £15,121, 31/12/53 £10,581)		9,855
76		Interest accrued		52
247		*Cash at Bank*		—
	30,971			30,971
		Current Assets:		
657		Debtors and amounts paid in advance	549	
100		Arrears of subscriptions recoverable (estimated)	100	
172		Interest accrued on investments (gross)	195	
2,550		Balances at banks and cash in hand	3,380	
	3,479			4,224
	51,039			56,799
		Frances Wood Memorial Fund:		
300		Investment, per schedule attached ... ... (Market Value, 31/12/52 £395, 31/12/53 £433)	300	
266		Post Office Savings Bank Deposit	288	
	566			588
	£51,605			£57,387

NOTE.—

No value is placed in the Accounts on—

(a) Journals and other publications in stock.

(b) Books in library.

(c) Pictures, furniture and equipment, other than furniture taken over with the Leasehold Premises, £225 (see above).

R. A. FISHER, *President.*

R. F. FOWLER, *Honorary Treasurer.*

THE AUDITOR

which, in my opinion, respectively give a true and fair view of the Society's affairs as at 31st the best of my information and the explanations given to me and as shown by the books.

A. RAE SMITH, *Chartered Accountant,*
Auditor.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPENDIX D

SCHEDULE OF INVESTMENTS—31st DECEMBER, 1953

1952			*1953*		
Market Value (less accrued interest)	*Book Value*		*Nominal*	*Book Value*	*Market Value (less accrued interest)*
£	£		£	£	£
6,139	*5,580*	2½% Consols (Guy Bequest)	10,528	5,580	6,790
1,304	*1,185*	2½% Consols	2,237	1,185	1,443
1,457	*1,324*	3½% Conversion Loan	1,865	1,324	1,587
388	*490*	3½% War Loan	500	490	422
1,366	*1,486*	3% Savings Bonds, 1955–65...	1,487	1,486	1,433
2,461	*2,992*	3% Savings Bonds, 1965–75...	2,970	2,992	2,625
2,000	*2,000*	3% Defence Bonds	2,000	2,000	2,000
150	*100*	British Transport 3% Guaranteed Stock, 1978–88	195	100	165
—	—	British Electricity 3½% Guaranteed Stock 1976-79	5,302	4,961	4,961
£15,265	*£15,157*			£20,118	£21,426
		Building Fund:			
£1,203	*£1,432*	3½% Conversion Loan	1,588	£1,486	£1,365
		1950 Benefaction Sinking Fund:			
£212	*£212*	British Electricity 3½% Guaranteed Stock, 1976–79	699	£646	£657
		1950 Benefaction Fund:			
£15,121	*£15,249*	British Electricity 3½% Guaranteed Stock, 1976–79	11,312	£9,855	£10,581
		Frances Wood Memorial Fund:			
£395	*£300*	British Transport 3% Guaranteed Stock, 1978–88	513	£300	£433

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PROCEEDINGS OF THE ONE HUNDRED AND TWENTIETH ANNUAL GENERAL MEETING OF THE ROYAL STATISTICAL SOCIETY, held at the London School of Hygiene and Tropical Medicine on Wednesday, June 23rd, 1954.

The Chair was taken by the President, Professor Sir Ronald Fisher, F.R.S.

The President presented the Report of the Council for the financial year 1953 and the session 1953–54, and moved that it be received.

During his submission of the Report the President presented the Guy Medal in Silver to Mr. L. H. C. Tippett, and Diplomas and Certificates to the successful candidates in the 1954 examinations who were able to be present at the meeting.

The Honorary Treasurer, Mr. R. F. Fowler, presented the accounts and seconded the motion that the Report be received.

On being put to the meeting the Report was formally received.

On the proposal of Professor A. Bradford Hill, seconded by Mr. L. H. C. Tippett, Sir Alan Rae Smith was unanimously re-elected Auditor of the Society for the session 1954–55, at a fee of fifty guineas.

The President announced that as no alternative nominations had been received, the President, Council and Officers for the session 1954–55, nominated as shown on the list already circulated, were duly elected.

The meeting then terminated.

The Annual General Meeting was preceded by an Ordinary Meeting at which the following were elected Honorary Fellows of the Society:

Professor Felix Bernstein	United States (now resident in Germany).
Professor Harald Cramér	Sweden.
Professor Georges Darmois	France.
President Luigi Einaudi	Italy.
M. A. Teixeira de Freitas	Brazil.
Herbert Marshall, O.B.E.	Canada.
Professor P. C. Mahalanobis F.R.S. . . .	India.
Stuart A. Rice	United States.
Walter A. Shewhart	United States.
Professor George W. Snedecor	United States.
Professor Otto von Zwiedineck-Südenhorst .	Germany.

The candidates named below were elected Fellows of the Society:

Reginald Grills
John Charlton Overton
Brian John Phillips
Brian Rye

Corporate Representative

Roger Arthur Leeks, *representing* Kodak Ltd.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

PAGE

1.—Uppsala Symposium on Psychological Factor Analysis, 17–19 March, 1953 . 482
2.—*Wold* (*Herman*). A Study in the Analysis of Stationary Time-Series. 2nd ed. . 484
3.—*Sukhatme* (*P. V.*). Sampling Theory of Surveys with Applications 484
4.—*Schmid* (*Calvin F.*). Handbook of Graphic Presentation 485
5.—*Fryer* (*H. C.*). Elements of Statistics 486
6.—*Hultgren* (*T.*) & *Greenwald* (*W. I.*). Transport and the State of Trade in Britain . 486
7.—*Silverman* (*R.*). Advertising Expenditure 1952 488
8.—*Irvine* (*A. G.*). Marketing Research and Management 489
9.—*Cairncross, A. K.* (*Ed.*). The Scottish Economy: A Statistical Account of Scottish Life by Members of the Staff of Glasgow University 490
10.—*Thomas* (*Brinley*). Migration and Economic Growth: A Study of Great Britain and the Atlantic Economy 491
11.—*Kuznets* (*S.*). Economic Change: Selected Essays in Business Cycles, National Income and Economic Growth 492
12.—International Definition and Measurement of Standards and Levels of Living. Report of a Committee of Experts 493
13.—*Fabricant* (*S.*) & *Lipsey* (*R. E.*). The Trend of Government Activity in the United States since 1900 494
14.—*Lengyel* (*S. J.*). International Insurance Transactions: Insurances in the Balances-of-Payments 495
15.—*Huff* (*Darrell*). How to Lie with Statistics 496

1.—*Uppsala Symposium on Psychological Factor Analysis*, 17–19 *March*, 1953. Nordisk Psykologi's Monograph Series No. 3. Copenhagen: Ejnar Munksgaard. Stockholm: Almqvist & Wiksell, 1953. 91 pp. 9″. 10 *Dan. cr.*

This booklet contains five papers given at a symposium held at Uppsala on the initiative of Professor Wold. The papers are "Factorial analysis as a psychological technique" by Professor E. A. Peel; "Factor analysis in psychology as a statistician sees it" by Professor M. S. Bartlett; "A modified method of estimation in factor analysis and some large sample results" by Dr. D. N. Lawley; "Some artificial experiments in factor analysis" by Professor H. Wold; and "On simultaneous factor analysis in several populations" by Dr. G. Rasch. There is also an account of the verbal discussion of the papers edited by Dr. Whittle.

With these five there should be considered another paper by Whittle "On principal components and least square methods of factor analysis" in *Skandinavisk Aktuarietidskrift*, 1953, **53**, 223. It is rather a pity that Whittle's paper was not bound up with the others, since it was presented and discussed at the symposium and is closely connected with Wold's paper.

Professors Peel and Bartlett will forgive me, I hope, for passing over their papers, which are largely expository, and proceeding at once to Dr. Lawley's. Lawley begins by making a distinction between two types of model in factor analysis. Suppose that (in his notation) the score of the ith individual on the ith of a set of p tests is represented as

$$x_{ij} = \sum_{r=1}^{k} l_{ir} f_{rj} + e_{ij} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where e_{ij} is a residual. In the first model (the one considered by Whittle) the l's are unknown parameters which are to be estimated; and so also are the f's, the jth individual bearing a value f_{rj} of the rth factor. The e's are regarded as stochastic residuals which, in particular, may be taken to be normally distributed about zero mean.

This is the approach which would ordinarily suggest itself to a statistician. The psychologist however, often wishes to regard the so-called "error" as comprising two components, a specific factor s_i peculiar to the ith test and a residual error which is, presumably, something in the nature

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of an error of observation or a superposed error in the equation. He continues to regard the residuals e as stochastic, and this involves regarding the specific factors s as independently and normally distributed over the population. This being so, says Lawley, it is not unreasonable to suppose that the common factors f are also distributed normally. From this point of view the parameters l are under estimate but the factors f are not.

This distinction is worth making, and bears a resemblance to the distinction between the two basic models of variance-analysis. But I am far from sure that the second model, which is the one that Dr. Lawley discusses, is amenable to the method which he uses. He writes down the likelihood of his observations in terms of the parameters l, the sample covariance matrix of the x's and the variance σ^2 of e (assumed the same for all i) and then maximizes it by differentiating with respect to the l's (and also with respect to σ if this is unknown). But, if the f's are variates equation (1) is merely a variate transformation and under it the likelihood remains constant. So far as I can see, what Dr. Lawley is doing is not a maximum-likelihood estimation in the ordinary sense but the determination of parameters in a variate transformation. If this is correct, it is not surprising that he emerges with a principal component solution (as he does) because in effect he has performed a principal component analysis.

The remainder of the paper contains a useful exploration of the large-sample standard errors of the solutions for the l's (and σ where necessary). They relate, in my view, to the characteristic roots and vectors of a sample dispersion matrix and, rather oddly, do not seem to have been given before, although Hotelling derived parallel results for canonical correlation analysis in 1936.

It is convenient at this point to consider the alternative approach of Dr. Whittle. He proceeds from equation (1) by least-squares, minimizing for variations in the l's and f's the sum of sample values

$$\Sigma (x_{ij} - \Sigma l_{ir} f_{rj})^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

There is a substantial difficulty here because the number of parameters under estimate exceeds the number of observations. Whittle overcomes it by a procedure which seems to me to beg the question entirely. He differentiates (2) with respect to the parameters l and f without imposing any conditions on them. Then, he says, from the form of (1) we see that it is no restriction to fix the scales and the mutual relations of the estimated values of the f's (or their true values) so that they are orthogonal. This is beyond me. If the values of the f's are orthogonal, the process of minimization ought to take account of the relations connecting them; and in any case this is not the same thing as supposing that the estimates are orthogonal.

In fact, it seems that to make the problem of estimation determinate Whittle has to impose substantial restrictions of an orthogonal kind on his estimators. What he is doing, I think, is only a principal component analysis in disguise, though a different disguise from Lawley's. And again it is not surprising that he emerges with what is, essentially, a principal component solution.

Professor Wold gives the results of some sampling experiments designed to test Whittle's least-squares approach to the first model. A number of series were constructed according to equation (1) with chosen values of the l's, the values of the f's and e's being normal random deviates. Following Whittle's procedure he estimates the l's, the factors, the dispersion matrix of the estimates and so forth; and finds perfect agreement with the theory.

But Professor Wold also begins by testing the "number of significant factors"—known in point of fact to be one or two. Here also I have doubts whether Professor Wold is really doing what he supposes. The characteristic roots of a dispersion matrix do not require testing for significance If the matrix is of rank r the parent cannot be of lower rank than r and each latent root of the sample matrix is therefore significant in the sense that if it differs from zero at all, by however small an amount, it cannot emanate from a zero value. What Bartlett's test (used by Wold) does is to test, in a rather approximate way, the *distinguishability* of the characteristic roots and it says nothing whatever about their number; and what Wold's experiment confirms, so far as I can see, is that the test works. The agreement found with Whittle's theory does not impress me in view of the foregoing comments.

There is nevertheless much that is valuable and stimulating in Wold's paper; and with one basic principle at least I am in most complete accord with him, namely the importance of carrying out practical tests such as these.

The short paper by Dr. Rasch, as he himself remarks, is only a first contribution to his topic. He makes the useful point (referred to incidentally by others) that the standardization of scores and factors may introduce considerable error into certain kinds of factor analysis especially where the same battery of tests is applied to samples from several different populations.

This is a useful booklet, but should be read, so to speak, at the monograph level. It is not suitable for beginners.

MAURICE KENDALL.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2.—*A Study in the Analysis of Stationary Time-Series.* By Herman Wold. Second ed., with an appendix by Peter Whittle. Stockholm, Almqvist & Wiksell, 1954. viii + 236 pp. 9¾". 38 Sw. kr.

Professor Wold's little classic, though written as a research report and an expository survey, has in fact been a standard text since its first publication in 1938 and a second edition is very welcome. Except for a few minor alterations the original text has been reproduced. The new matter consists of a few notes on that text and a new appendix of 33 pages by Dr. Whittle on recent developments in the theory of stationary processes.

Much has indeed happened in the last sixteen years in the theory of time-series and an up-to-date presentation is urgently needed. Dr. Whittle's appendix, though not comprehensive (little is said of the distribution theory of serial correlations or the important question of bias in estimation) gives a very useful introductory account of spectral theory, of estimation and the interpretation of harmonic components and of the part of the subject studied by Dr. Whittle himself, namely inference and tests of fit. The treatment is necessarily rather condensed and no numerical examples are given. In a way, perhaps, this is a pity because non-artificial numerical examples in time-series have an awkward habit of disagreeing with the theory, especially asymptotic theory; but doubtless to have included them would have extended the appendix beyond reasonable bounds.

Some of Dr. Whittle's views on the testing of hypotheses in time-series analysis are original and would not command general assent. I remain to be convinced, too, about his treatment of Fisher's test for periodic components in harmonic analysis by approximations, which may be justified in the limit but not for the sort of series to which one wishes to apply the test. However, the appendix serves a useful purpose in bringing the main text more up to date.

The page references to the new material in the index seem to have a standard error of one or two units: Tippett (misspelt) appears on page 231, not 232. Turvey (said to appear on page 232) does not appear at all; Whittle and Wold are said to appear on p. 234, which is the first page of the index itself; and there are a few others of the same kind. MAURICE KENDALL.

3.—*Sampling Theory of Surveys with Applications.* By Pandurang V. Sukhatme. New Delhi: The Indian Society of Agricultural Statistics. Ames, Iowa: The Iowa State College Press. [1953.] xxix + 491 pp. 10". n.p.

Dr. Sukhatme, known for his research contributions in the theory of sampling, has used the material of various lecture courses he has given to produce a text-book for an advanced course in the sampling theory of surveys, and one which will also serve as a reference book for statisticians engaged in the planning of surveys. A number of books on this topic have appeared of recent years, but there is room for more, and this one in particular has an individuality of its own, although the general contents of such a book have by now become fairly standard. It begins with basic ideas in sampling and basic theory, on the two models of simple random sampling and of sampling with varying probabilities of selection. The mathematics is nowhere very difficult, but some of the formulae, e.g. for unbiased estimates and for the variances of such estimates, are more complicated than usual owing to the conditions of the sampling, and in particular because account is taken of the finite size of the population.

A further chapter deals with stratified sampling, selection being done either with equal or varying probabilities. Two chapters follow, dealing respectively with the ratio method and the regression method of estimation. The choice of sampling unit is then considered for equal and unequal clusters. Sub-sampling comes next in the two cases of equal and varying selection probabilities. A short chapter deals with systematic sampling, and the book winds up with an interesting chapter on non-sampling errors, the algebraic treatment of which is not considered by the author to have been sufficiently stressed hitherto in the literature.

The book is informative and easy to read, the necessary formulae being worked out and displayed in full detail. A beginner to the subject with some mathematical competence should therefore have no difficulty in following the theoretical treatment. To give examples is always instructive, and this the author does, but in one case at least, namely at the very beginning, he has not been altogether successful in exposition. He cites in §1.5 a very simple case of a population of four farms of stated acreage, in order to list all the possible samples of size two which can be drawn from the population. In Table 2.1 he makes calculations based on the mean and mean square of the six possible samples, and he calculates confidence limits in Table 2.2. The formulae are in the book, and the figures are in the tables, but the reader would have been helped by some explanation of how the figures were arrived at. For example, the sample of values 2 and 3 yields an obvious mean of 2·5, but it could have been explained that s^2 is easily arrived at by taking half

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the square of the difference of 2 and 3. Later $s^2 - S^2$ is calculated without a statement that S^2 is directly calculated as 14/3. It would also have helped to state, certainly with reference to Table 2.2, that $n = 2$ and $N = 4$. But this is a minor criticism, having reference to the fact that it is not enough in general to provide the worked-out figures in an example; some guide through the calculations should also be given. The only Tables provided in the book are one of random numbers, and a pair giving the augmented symmetric functions in terms of power sums, and *vice versa*.

J. WISHART.

4.—*Handbook of Graphic Presentation.* By Calvin F. Schmid. New York: Ronald Press, 1954. vii + 316 pp. 9½″. $6.

The presentation of the results of statistical analysis in forms which are intelligible to laymen is sometimes a necessary and tedious part of the statistician's work ; but the expert often underrates the difficulty of devising a presentation which is objective, intelligible, and sufficiently attractive to arouse the layman's interest. Unfortunately, those who most need enlightenment and guidance on methods of presentation are unlikely to be informed by Professor Schmid's handbook, though those who are already aware of the difficulties, and know clearly what they want, may find it useful as a source of ideas.

The charts and diagrams described in this handbook have a two-fold purpose : the first is to interpret for the layman the salient features of descriptive statistical data; the second is to attract attention to statistical analyses which, in their numerical or tabulated form, the layman might ignore. Nomographic charts and other aids to computation are thus excluded. It is evident from the many charts and diagrams of his own design with which he illustrates his book that the author, who is Professor of Sociology and Director of the Office of Population Research at Washington State University, Seattle, has had long experience of presenting the results of his researches to lay committees and to the general public.

The handbook rightly begins with a discussion of the basic principles of presentation. This should be the most important part of the book ; it should furnish the reader with criteria for selecting what he needs from the profusion of examples which follows. But, after a graceful acknowledgement of the pioneer work of William Playfair, the discussion is disappointingly inadequate. We are told for example (p. 8) that "a chart prepared for a popular audience unfamiliar with the more technical type of graphic presentation would be different from one designed for a comparatively small, highly trained group of specialists", but that is both the beginning and the end of the discussion.

The greater part of the book is devoted to a comprehensive, detailed and fully illustrated description of the main categories of charts and diagrams, including statistical maps and the use of Isotype. The 200 illustrations are well chosen to exemplify the technical details of constructing charts and the mistakes, explained in the text, which are sometimes made. But many of the charts described with the approbation of the author are much too elaborate for British, though possibly not for American, use, especially those which are drawn on what are called "detailed artistic" or "pictorial" backgrounds and are otherwise embellished with distracting devices to awaken "human interest". The first principle of the graphic presentation of statistics to laymen is that the graph must be simpler for them to understand than the numerical data it represents—but experiment is needed to establish what the simpler forms are. And if a chart attracts attention does it follow that it necessarily conveys its information? It is surprising that a sociologist with many opportunities for testing the effectiveness of his graphic presentations on those for whom they were intended seems to have made no experiments on the presentation of his results. Some experimental check would be salutary; without it there is a danger that the graphic presentation of statistics may become an end in itself—a new art form.

Almost all the examples used as illustrations have been abstracted from books and published documents; such illustrations are intrinsically more interesting than inventions would be but they should illustrate emotively neutral subjects. At least one chart reproduced here (Fig. 29, p. 56) is offensive; the chart itself, used simply to illustrate a technical point, is left to make its emotional impact on the reader with none of the comment its objective interpretation demands. It is out of place in this handbook.

There are two chapters on drawing-office techniques and methods of duplicating graphs and charts; they contain some useful hints, e.g., on the drawing of logarithmic scales, but most of the instruction given is at the level of "how to ink a drawing pen."

This handbook would be more useful and convincing were it less pretentious.

B. C. BROOKES.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5.—*Elements of Statistics.* By H. C. Fryer. New York: J. Wiley & Sons. (London: Chapman & Hall), 1954. viii + 262 pp. 8″. 30*s*.

This work is based on lectures given by Professor Fryer to students with little or no mathematical training and taking their first course in statistics. The seven chapters are "History and Introduction", "Summarization of Sets of Data Involving One Type of Measurement", "Elementary Probability", "Binomial and Normal Frequency Distributions", "Sampling from Binomial Populations", "Introductory Sampling Theory for a Normal Population Involving only One Variable", "Linear Regression and Correlation". The chapter on probability includes a careful account, with the minimum of mathematics, of permutations and combinations. The following topics—the Poisson distribution, analysis of variance, the F distribution and experimental design—are not discussed.

Given the choice of subject matter and the mathematical level, the book is excellent. The treatment is leisurely, very well illustrated by examples and interesting exercises and the key ideas are carefully and clearly explained. The illustrations are drawn from a wide range of applied fields. The only small errors that have been noticed are the diagrams of the normal frequency curve (pp. 91, 92) which are badly drawn, the statement on p. 108 that a normal distribution with a section missing gives a linear plot on probability paper, the definition of efficient estimates on p. 123 (a later definition is correct), and a slip in a t multiplier on p. 214.

The book will be of interest to teachers of elementary statistics. It is suitable for students provided that they are interested primarily in getting a thorough understanding of basic ideas rather than in building up quickly a set of techniques for practical use. It is not suitable as a reference book for the research worker, both because of its limited scope and because methods of computing are not dealt with at all fully.

D. R. Cox.

6.—*Transport and the State of Trade in Britain.* By Thos. Hultgren assisted by William I. Greenwald, National Bureau of Economic Research Inc. Occasional Papers, No. 40. New York: 1953. xii + 114 pp. 9″. $1.50.

In this book Mr. Hultgren has attempted to study the behaviour of transport in Great Britain by the methods employed in "American Transportation in Prosperity and Depression", which was reviewed in this Journal, Volume CXII, Part III, 1949, pages 340–342. The main technique of analysis employed is that of relating the peaks and troughs of certain statistical series (passenger journeys, tons, etc.) to a system of "reference cycles" or "cycles in total business" as the author calls them. The reader of this book is not told how these "reference cycles" are determined in the first place, nor whether there is any circularity of reasoning in examining railway activity with reference to general fluctuations in trade, the estimates of the magnitude and turning points in which may have been influenced by the changes in railway traffics themselves.

After an introductory chapter on traffic and business, in which it is made clear that this book is part of the National Bureau's comprehensive enquiry into business disturbances, based on the work of Arthur F. Burns and the late Wesley C. Mitchell, the author turns to a discussion of the movement of goods. The close coincidence between variations in the production of coal and the quantity of railway freight traffic is hardly surprising as coal, coke and patent fuel during the period covered accounted for roughly three-fifths of the tonnage of all goods carried, but there is an interesting estimate of the total tonnage of certain other commodities produced in, or imported into, Great Britain. Together these covered roughly half of railway traffic other than coal, and there is an attempt to relate this production data to the tonnages of goods actually carried by rail, thus partly circumventing the difficulties resulting from the absence of statistics about road goods traffic. The proportion of these particular goods passing by rail fell throughout the period 1928 to 1938, although, of course, these figures deal with tons and not with ton miles, so that it is not possible to say how far the average length of haul of these traffics was increasing. The author concludes that the share of the railways in the carriage of these goods tended to fall more rapidly in depressions. This is perhaps the most interesting part of the book, and contains data which might be of much wider application if one could know a little more about the procedures and estimates which must have been involved in preparing and working up the information. There are no published railway statistics giving the tonnages of different commodities carried which would permit the extension of the series to the years since 1938.

The second chapter deals with the movement of persons, and the conclusion is reached that passenger travel showed smaller fluctuations than the tonnage of goods. The analysis is hampered by the absence of passenger mile statistics for the railways for the years before 1938. The road

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

transport aspect of this chapter might have been improved if the author had consulted relevant papers in previous issues of this *Journal*. For instance, in Part II for 1904, a paper by Mr. (later Sir Edgar) Harper gives statistics of passenger traffic on London buses from 1867 and trams from 1878. In Part III of 1950 two papers by Mr. F. A. A. Menzler give further information and references on rail and road statistics in general and London Transport in particular.

The third chapter covers the fluctuations in the use and quantities of rolling stock on the railways. The conclusions are the familiar ones that in times of vigorous economic activity stock is used more intensively, train loads and wagon loads are heavier and equipment is used for more of the time, but that goods trains move more slowly.

The fourth chapter discusses maintenance policy, concluding that maintenance of track fluctuated less than traffic but that maintenance of rolling stock varied as much as traffic.

The third and fourth chapters are therefore dealing with what might be called "second stage" effects of the fluctuations in economic activity, that is, not the primary impact on the volume of traffic but the changes in railway policy, particularly in investment policy, which result. These variations in investment policy are the result not only of the magnitudes of the primary variations in traffic but also of the views taken by the directors and managers of the probable future course of events. In other words the fluctuations in these "secondary" statistics reflect the optimism, pessimism or lethargy of railway managements in the conditions of the twenties and thirties. It is questionable how far it is safe to base lessons for the future—in the manner suggested by the first paragraph of the foreword to this book—upon the effect of psychological conditions which may belong wholly to the past. The managers may not react the same way next time.

It also follows that railway track maintenance policy in a period of what was regarded by managers as a cyclical decline in traffic would not be the same as in a period of secular decline which was not expected to be followed by an upswing. In the former case it might not be thought worth disturbing rules of thumb about the frequency of renewals and maintenance, whereas in a once and for all decline substantial alterations might be made. A study of what was actually done in declines regarded as cyclical and likely to be followed by recovery can throw no light on what could be done if the decline in traffic were regarded as permanent.

Chapter five discusses the use of labour and fuel and chapter six the financial returns. The familiar conclusions are reached that railway staffs were not adjusted to falls in traffic and that more effective work was performed for a given quantity of fuel in periods of heavy traffic than in those of light.

In Chapter seven the author discusses traffic and operations since 1938. The term "cycle" continues to be applied to this period—for example "Operations during the war cycle"—so that it becomes increasingly difficult to know what it means. Does it mean an "up" plus a "down", because if so there has been no "down" since 1938 to correspond to the "up" of 1939–1942? Does it mean a fluctuation of business activity generated by business influences as opposed to governmental action, because if so it is difficult to detect anything of the kind between 1939 and 1950 in Great Britain? It cannot be interpreted as a particular number of years, since 1939 to 1950 is as long a period as 1927 to 1938, which covered more than one full cycle on any analysis. In fact it could be argued that to extend this kind of "cyclical" analysis into the years 1939 to 1950 merely emphasises the artificiality of the concept and may give the impression that the value of the work in post war conditions is even less than it really is.

It would appear from Chapter 9, entitled "Toward Understanding Cycles" that the term "cycle" covers almost any fluctuation in business activity or even an interruption of a process of growth. This would justify the scope of the analysis in this book but seems to take the study some way from the kind of thing most people think about when they hear the words "cycle" or "trade cycle". Indeed, the use of the term "cycle" in connection with series of observations which do not move in a periodic fashion is open to grave objection.

Chapter eight gives an interesting comparison of British and U.S. experience. The comparison of the relative severity of depressions in the two countries is hampered by differences in the rates of growth of the economies, and although in general operating experience in times of boom shows similarities this too is partly cloaked between the wars by the greater technical progress on U.S. railways. In both countries the prices the railways charge for their outputs were much more stable than their unit costs.

To sum up, this book inspires a mixture of exasperation and respect. The exasperation is aroused by the trite and obvious nature of many of the statements—"neither a train carrying goods nor a passenger train can run except over tracks in a usable condition", and by the confusing use of the word "cycle". One's respect is commanded by the industry of the author and his collaborators, by their general success in avoiding pitfalls in the statistics they have used and the painstaking nature of the analyses.

K. F. GLOVER.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

7.—*Advertising Expenditure* 1952. Prepared for the Advertising Association. By Rodney Silverman. London: The Advertising Association, 1954. xi + 63 pp. 21*s*.

This is the third "benchmark" produced from the surveys of the size and nature of United Kingdom advertising expenditure with which the author has been concerned. Previous data have been procured for pre-war years and 1948. In most commercial statistical work, the problem of securing reliable data in a comprehensive yet manageable form is extremely complex, and considerable estimation is inevitable if data secured are to be useful. As more data emerge, refinements can be made on earlier work, and Mr. Silverman is now able to present estimates interpolated comparably from 1946 to 1953, which make sense and also include much new material revealing, for example, size the of activity in retailers' advertising.

The problem has been approached from three practical angles: data securable from (*i*) the owners of "media"; (*ii*) advertising agents (linkable here and there to the former); (*iii*) advertisers (especially for miscellaneous expenditure).

Mr. Silverman is to be complimented especially on the clarity of his definitions. But demarcation of the borderline where advertising cost ends, and sales promotion cost begins, is not possible. The two should, from the economic viewpoint, be regarded as two approaches with the same object, complementing and fortifying each other in a scarcely separable way.)

It says much for the interest in, and need for, such data, that so many in each group were able to co-operate voluntarily in making up the difficult "return". The approach to advertisers is obviously the most likely to provide an unrepresentative picture. By weighting on a plausible, if arbitrary, basis as between large and small firms, Mr. Silverman convinces us that the expectable variance is generally negligible, and where it does increase the obvious reasons permit sensible adjustments to be made to the basis. Similar reliance is placed on the consistency shown within the relatively small number of retailers' returns.

Whereas the amount and sources of data used by the advertising professions are legion, it is perhaps ironic that the only useable current series of date on the trade's turnover itself is also "Legion"—the Legion Publishing Company's "Statistical Review of *Press* Advertising", to which due acknowledgement is made. The new study thus obviously provides badly needed facts serving as a basis for intelligent discussion of the place of advertising in the economy and society, and filling a vital gap for those who try to use "media" in an efficient way. It is greatly to be hoped that groups within the trade will be encouraged to collect and publish more detailed material by product groups, both for the economist and the marketing executive, and will realize how such data can foster their interest in the long run.

The corrected perspective provided by the study is striking. Whereas advertising in its widest sense represented 2·1 per cent. of the national income pre-war, it has only crept back to 1·7 per cent. by 1953, from the low levels of the war-time and restrictive era. Paper shortage also appears a contributory to the shift shown between the various "media's" "share of market". Our advertising/income ratio is put at 60 per cent. of that in the United States, and is seen to have lagged behind considerably in post-war years. The emergence of commercial television, and the return of full competition, may accelerate a trend back to normality.

Attempting to put the salient economic facts in simpler terms than the author's is difficult. About £2 per head per year goes to the Press, the absence of which would add over 2*s*. a week to the average home's "reading" bill. Only ⅓ of a penny per head a week was going out in 1952 in free samples and gift schemes—hardly enough to warrant the alternative reduction in retail prices when offset by the advantages of stimulating demand directly.

The shifts between "media" are very carefully plotted. Radio has made a "come-back" since 1948. (Television has still to affect the market.) Window display has trebled and is well over pre-war levels—a trend we are all as observers perhaps unconsciously aware of. Exhibition work fell from the 1951 Festival year peak. Administration costs have hardly kept pace with wage increases since 1948, though costs as a whole in the trade have risen more steeply, compared with pre-war levels, than have "factor costs" elsewhere. National newspaper "display" advertising has doubled since 1948, while magazine, provincial, technical and trade press advertising are all 60 per cent. up. It is very useful to have these trends recorded in figure form.

The slenderness of the data available in other non-American countries, for comparison, shows how much a pioneering work this is. The sectional arrangement is very practical: Advertising Expenditure; National Income and Total Sales; Distribution of Expenditure by Media; Sources of the Expenditure; Turnover and Expenditure of Advertising Agents; Trends in Specific Media. All these contain data of interest to one section of the trade or another. Advertising expenditure *to* manufacturers, etc., takes a quarter of the total, so not all goes direct to the general public, as many imagine.

Over 54 per cent, of the total spent goes to the Press. Only 48 per cent. is bought by manufacturers; over 20 per cent. by retailers. Agents handled only 46 per cent. of the total turnover.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The £190 millions spent in 1952 in helping dispose of £22,000 millions of total sales (i.e., including intermediate transfers from a seller to a buyer) seems a very small price to pay for the "oiling of the distributive machinery".

The one drawback to the book from the reviewer's viewpoint is that, as previously mentioned, no full post-war data by product, or commodity, groups advertised—the only practical marketing basis—have as yet become available from the Advertising Association's researches, but that is beside the point here.

J. I. MASON.

8.—Marketing Research and Management. By A. G. Irvine. London: Macdonald & Evans, 1954. ix + 275 pp. 8½". 30*s*.

Mr. Irvine was prompted to write this book after the award of a Travelling Scholarship by the Institute of Industrial Administration and a visit to the United States. This background is demonstrably insufficient, and Mr. Irvine's attempt to cover his subject is hindered also by a fundamental confusion as to definitions and purposes. He does not distinguish clearly between "Market" and "Marketing" Research; nor does he finally decide whether the book is designed to explain research to management or to instruct the research student. For the former, it is too detailed and for the latter, insufficient.

The first part of the book deals briefly with the development and scope of Marketing Research. This seems to be based entirely on two American "check lists" (dated 1947 and 1945 respectively) which tabulate, in excessive detail, all the possible functions of research. It would have been more helpful if this section had been illustrated with some case histories of investigations with which the author had himself been concerned.

Chapter III—Marketing Research Procedure—gives a straightforward description of the conduct of research, from the essential initial analysis of the problem to the presentation of the results of the inquiry. Research practitioners in this country will be interested to see that Mr. Irvine apparently assumes that the individual in charge of Marketing Research will be free to select his own subject for investigation, although later on (p. 254) he suggests that the Research Manager may in fact have to take his orders from above, which brings his account a little nearer to real life.

The final step in Research Procedure is described under the heading of "Follow-up" and here too Mr. Irvine suggests that it should be the responsibility of the Marketing Research Manager to consider what action, if any, has been taken. This is surely the function of top management and not the responsibility of the executive in charge of the inquiry. The Market Research Manager, who ". . . may use a mechanical system based upon reminders to executives sent after the lapse of a proper length of time . . ." may well do himself more harm than good.

In the short section on machine tabulation we read ". . . where many different inquiries are being conducted there is difficulty in obtaining speedy delivery of printed tabulating cards designed for each inquiry. The cost of printing new types of card is also high". This could surely not have been written by anyone who is in the habit of using machine tabulaton for Marketing (or Market) Research purposes.

The author's somewhat idealistic view of the function of the Research Manager is in contrast to his opinion of those who fill these posts. For example, in the introduction to the chapter on Sampling Procedure he says: "Some training in mathematics is essential for the director of any investigation who is to employ modern methods of sample design, and it is unfortunately true that many of the directors of marketing investigations today have "come up the hard way" and are innocent of even elementary mathematics". One can only assume that these remarks are due to an ignorance of the work that is being conducted in this country and of the people who are doing it.

The bibliographical references leave something to be desired—Sir Ronald Fisher's work, "Statistical Methods for Research Workers" is one of the last books to be recommended to the beginner, and there is no reference to such necessary texts as Ferber's "Statistical Techniques in Market Research" and Deming's "Some Theory of Sampling". Reference might also have been made to the new and important work by Hansen Hurwitz and Madow which, although not then available in England, was known in 1953. Among the articles listed in the bibliography there is only one reference to anything published after 1947 and no mention is made of the valuable work of members of the Government Social Survey and the Division of Research Techniques at the London School of Economics.

The third section of the book describes the questionnaire technique, retail audits and consumer panels and again something less than justice is done to the information available in this country.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In the last section of the book dealing with the relationship between Marketing Research and Management Mr. Irvine makes a worthwhile contribution. He very rightly points out in his summary of this final section that "The authority exercised by Marketing Research in its supervisory relationship is one of ideas . . ." but, as is well known to practitioners in this field, the implications of this simple statement are vitally influenced by the structure of the individual organization and by the personalities involved.

The summary is preceded by an examination of the different forms of Management and, as in the first section, the relationship of Marketing Research to these various activities is condensed into yet another check list. The book concludes with a chapter on the way in which the Research Department should be organized.

B. D. COPLAND.

9.—*The Scottish Economy: A Statistical Account of Scottish Life by Members of the Staff of Glasgow University.* Edited by A. K. Cairncross. London: Cambridge University Press, 1954. xv + 320 pp. 9″. 30*s*.

The visitor to Scotland quickly becomes aware both of differences from the English mode of life and of the Scot's delight in differing from the Southron. Are the two countries in fact distinct economies, or are their differences only those to be expected between regions in a single economy? Professor Cairncross and his team examine such economic and social statistics as are separately tabulated for Scotland in compilations of data relating to the United Kingdom as a whole and which are generally comparable without special caution (e.g. the population census and the unemployment records). In addition, they deal with data relating purely to Scotland and not exactly comparable with apparently similar statistics for England and Wales (e.g., crimes, which are classified differently because of the different law-system, and education, the structure of which has a different history). This examination of material brought together from different types ot source is conducted with care and with due warnings against any non-critical acceptance of apparent comparability. It supplies a factual background for the discussion of economic and social questions connected with agriculture, trade and industry, with the related subjects of wages and trade unions, with population in its various aspects, with housing, church-going, education and crime, and also with local government finance, this last being of topical interest in view of the recent report by the Committee on Scottish Valuation and Rating. Some sections of the symposium cannot be based on separate statistics of either kind and Scotland's share of the United Kingdom total (e.g., in national income, in exports or in imports) can only be estimated. This must have been the most difficult part of the task undertaken by the team and has been handled with circumspection. Where adequate data are lacking, that fact is stated and no rash speculations have been advanced.

The resulting series of analyses is well worth attention, not only by British readers and by Scots abroad, on account of the increasing interest taken in Scottish affairs and the vocal demand of Scottish public opinion for a larger measure of self-government, but by economists who believe that some problems might be more rewardingly studied in smaller fields than those provided by figures for a country as a whole. Such readers may find here encouragement to undertake regional comparisons where one region of a national unit differs from another in history, climate, religion or racial mixture. Business men from England and abroad who are considering opening works in Scotland will also find much relevant information in this compact and level-headed account of so many sides of Scottish life. To those who ask "stands Scotland where she did?" the sections on education, on the churches and on crime will be of particular interest. All three provide some surprises.

The general conclusion of the whole symposium, that Scotland is not keeping pace with either the economic or the social progress of England and Wales in recent years, is one meriting the attention of economists in both countries. Hydro-electric schemes, afforestation and development areas are clearly not enough in themselves to utilise to the full the potentialities of this distinct but integral part of the larger British economy. From a study of the facts presented by Professor Cairncross and his colleagues a fresh approach to the problem may become possible.

Some minor criticisms may be made. Occasional sentences still remain ambiguous to the reviewer after repeated re-reading. At the top of p. 223 a reference to Fig. 16 appears to relate to Fig. 15. In the section on births and deaths the different meanings given to "mortality" (a term used again without precise definition in the section on health) are so confusing that it is hard to be sure which is borne by the word in a given sentence. The subject-index seems to have

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

suffered from over-compression and entries in it are not always consistent. It may be added that now and then the appearance of such purely Scottish words as "outwith" may puzzle readers not versed in the writer's mother-tongue. But these are details noticed in passing.

J. I. DOUGLAS

10.—*Migration and Economic Growth: A Study of Great Britain and the Atlantic Economy.* By Brinley Thomas (N.I.E.S.R., Economic and Social Studies, etc.). Cambridge University Press, 1954. xxv + 362 pp. 9¼″ 42*s*.

Since the end of the war, there has been, largely owing to the great displacements of population, a revival of interest in the problems of international migration. The factors influencing migratory movements have long been discussed by economists and others especially in the period of relatively free migration before the first World War. Has migration depended on conditions in the countries of immigration or on those in the countries of emigration: in other words, is migration a "push" or a "pull"? This book, although confined almost entirely to migration between the U.K. and U.S.A., throws valuable light on these questions, and is an important contribution to the study of the relations between economic development and migration movements.

In Part I (Hypotheses) the views enunciated by economists during the 19th century are expounded and discussed; in Part II (Description) the available statistics are explained and their sources and methods of compilation given. This subject as far as British statistics are concerned has now been covered more fully in the recent report of the General Register Office on "External Migration" (see review in this *Journal*, p. 238, 1954) but it is amplified here by a discussion of the U.S.A. statistics of immigrants from the U.K., and an attempt to explain some of the reasons for the discrepancies between the U.K. statistics and the U.S.A. statistics of the same phenomenon. No statistics of migration (i.e., change of residence) exist for the United Kingdom before 1912; before that date they consist of passenger movements. The U.S. statistics are also shown to be defective.

The most important and original part of the book is Part III (Analyses). By fitting curves to the annual data the author arrives at the "encouraging result . . . that over the entire period, the original data whether British or American are not likely to be misleading as a measure of *changes* in the migratory stream over time" (p. 55). These changes are shown by the four great "waves" of migration between 1840 and 1914 with "troughs" in the U.K. series in 1840, 1860, 1878 and 1897 (somewhat different dates are shown by the U.S. Series). These curves are then compared with others similarly compiled, purporting to measure "economic progress". A "relation" (i.e., similar movements) is shown to exist between the curves of economic progress in the U.S.A. (as measured by railway construction and coal output) and the course of trans-atlantic migration; such cycles of economic progress are found to be on the whole the reverse of those for the U.K. The author's curves also bring out an inverse relation between migration to the U.S.A. and building activity in the U.K. and a direct relation with building activity in the U.S.A. Income, wages and employment in the U.K. (which vary together) are shown to vary oppositely to the figures of net migration and investment. "When output of produce+durables, and construction," concludes the author, "was increasing rapidly in the U.S., the U.K. experienced a falling rate of real investment at home, a growing surplus in the balance of payments, heavy unemployment and a large outward flow of emigrants", but when the opposite was true, "relatively low rate of capital formation in the U.S. with the U.K. going through a phase of unusually high domestic investment, there was little emigration, slight unemployment and a contrasting balance of payments on income account" (p. 111). In the last 30 years, however, the fluctuations in economic activity (in the U.K. and U.S.) ceased to be inverse. This "disharmony . . . arose out of the fact that the West was absorbing population and capital from the East; the inverse relation ceased when the U.S. practically stopped importing labour from Europe and began to export capital on a considerable scale" (p. 226).

The author's analysis of the data into "secular cycles" of 20 years or so, is interesting and valuable but it is doubtful if the *annual* data on migration lend themselves to such a refined analysis as the author applies in chapter10 and appendix 3, where a "time-lag" analysis is employed. "Each of the series (of economic growth in U.S.A.) (railway construction, new building, coal output, etc.), has been paired with immigration from Europe and from particular European countries, and the technique for locating a switch in the direction of lag has been applied (p. 159)." Time lags in the reversal of trends are given for a number of paired series with their correlation coefficient. It is significant that only the U.S. statistics of British immigration are used in this analysis; the use of the U.K. series might give very different results. The following table shows (*a*) British figures of emigration to U.S.A. (including Irish), (*b*) U.S.A. estimates of immigrants from U.K. and Eire (for the years 1924 to 1930):

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Year.	(*a*) *Calendar year* (000s)	(*b*) *Fiscal years to 30th June* (000s)
1924	19	78
1925	30	54
1926	29	50
1927	26	52
1928	22	45
1929	31	41
1930	27	54

Although these data are not used by the author, whose analysis of time-lags does not go beyond 1913, and they are not typical of the differences in the two series throughout the 19th century, they illustrate the remarkable differences which can arise in a statistic purporting to measure an identical or almost identical phenomenon. Not only is the latter series over the period almost double the former but the turning points and trend reversals of the two series would be different. Time lag analysis might give different results according to the series used.

While the data on migration are subject to critical analysis by the author and their imperfections noted, the other series on "economic progress" used to show "relations" are accepted as published without discussion of their possible imperfections for the purpose in hand. The author states on p. 85, "as indices of the economic growth of the U.S. between 1830 and 1913 we shall use . . . the annual number of railway miles added and the production of bituminous coal"; on p. 115 he states, "we have already seen that the best indicator of the pulse of American economic development . . . is the annual addition to railway mileage." This has not been demonstrated in the intervening 30 pages.

The appendices are exceptionally complete and well presented with full and detailed tables of all the data used and exact references to sources.

J. W. Nixon.

11.—*Economic Change: Selected Essays in Business Cycles, National Income, and Economic Growth.* By Simon Kuznets. London: Heinemann, 1954. viii + 333 pp. 8½″. 15*s*.

The essays contained in this volume were published or read as lectures by Dr. Kuznets over a period of some twenty years. Dr. Kuznets' detailed and highly technical work in the broad fields described by his sub-title is well known, but this collection of essays is concerned, as he says in his preface, with the wider problems. Nevertheless they owe their inspiration to "reflections and questions arising from active participation in prolonged quantitative and empirical studies".

It is not surprising that a man of Dr. Kuznets' distinction and experience has many interesting and stimulating things to say. However, the method of presentation of his thoughts make his ideas appear much less interesting than they really are. In many of these essays, the labouring of simple points and exhaustive discussion generally have a somewhat soporific effect on even the most responsive and sympathetic reader. The subject of the essays may be "the larger themes", but they each tend to be treated as if they were a "prolonged . . . empirical study".

It is only fair to say at once that there are at least three notable exceptions to this general criticism. The first is Dr. Kuznets' exceedingly interesting and sympathetic review of "Schumpeter's Business Cycles". The second is the illuminating discussion of international comparisons of National Income in the essay on "National Income and Economic Structure". He is particularly concerned with the difficulties of comparing industrialized countries with those having a pre-industrial type of society—or, if you prefer it, with underdeveloped territories. He illustrates his arguments by making a statistical comparison of income per head in the United States and China.

Dr. Kuznets' approach to National Income problems is refreshingly lacking in dogmatism. He continually looks beyond the mere aggregates to the purposes for which they are to be used. He is careful to distinguish between the concepts that are relevant to a comparison of welfare and those that are needed when estimating the relative productive capacities of two countries, whether for war or peace. Even if Dr. Kuznets' views on the treatment of the Government sector of an economy are not in accord with other high authorities in this field, the healthy attitude of mind shown by his firm contention that much of Government activity is a means to an end rather than an end itself deserves our admiration.

The third essay, the quality of which forces itself on the attention of the reader, is "Economic Tendencies, Past and Present". In this, Dr. Kuznets says all the things that we like to hear Ameri-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

cans say at the present time about the part that their country should try to play in international economic affairs. That he should have put forward these views with such determination as long ago as 1941 is a remarkable tribute to his prescience.

Of the remaining essays one in particular deserves special comment. This consists of a very detailed examination of the conditions under which the acceleration principle is valid and is entitled the "Relation between Capital Goods and Finished Products in the Business Cycle." Dr. Kuznets concludes that the acceleration principle "is valid as an explanation of the demand for capital goods . . . when there is little overcapacity and no hesitation on the part of entrepreneurs to incur commitments—a situation that occurs sometimes in the later part of the expansion phase of cycles in rapidly growing industries". There are indeed grounds for doubting whether this particular bit of analysis is quite of a piece with the other essays in this volume, but nevertheless its inclusion as a sample of Dr. Kuznets' thoughts of some twenty years ago provides an unspoken but nevertheless telling criticism of recent extensive but uncritical use of the acceleration principle.

In the rest of this book Dr. Kuznets' discourses on the inadequacy of static theory as a basis for the discussion of business cycles; of the necessarily largely descriptive character of dynamic economics in its early stages; of the effects of economic trends on business cycles; of the relation between national income and economic welfare; on the causes of international differences in income levels; on the reasons why the economic growth of an industry must eventually slacken; and of the nature and domestic effects of the United States' international economic relations. If, in his treatment of these themes Dr. Kuznets does not often succeed in capturing the reader's imagination, nevertheless it is impossible not to be impressed by his consistent good sense and by his ability to combine shrewd analysis with intelligent observation. He stresses continually the need to integrate economic analysis, measurement, and history if we are properly to understand our present problems.

We should certainly be grateful to Dr. Kuznets for assembling this collation of his thoughts on the broader issues. We must regret that he could not distil them for us into a somewhat lighter brew.

A. D. Roy.

12.—*International Definition and Measurement of Standards and Levels of Living.* Report of a Committee of Experts convened by the Secretary-General of United Nations jointly with the International Labour Office and the United Nations Educational Scientific and Cultural Organization. New York, 1954. xii + 95 pp. 10¾". 6*s*.

The promotion of "higher standards of living" as set forth in the Charter of the United Nations, the great attention now being paid to the economically less-developed countries, and the technical assistance now being granted to these countries by the United Nations and its agencies, raise questions of how such standards should be measured for the purpose, in particular, of assessing the need of countries for such assistance and of recording progress in meeting need. On the request of the General Assembly, the Economic and Social Council asked the Secretary-General "to convene a small group of experts to prepare a report on the most satisfactory methods of defining and measuring standards of living and changes therein in the various countries having regard (*sic*) to the possibility of international comparisons". This committee, consisting of six experts from India, United Kingdom, the United States, Sweden, France and Brazil, met in 1953 and its report has now been published.

The committee first attempted to clarify the concept "standard of living". It noted that this term is used to mean either actual living conditions, the living conditions people hope to attain, or the desirable conditions of living for specific purposes (sometimes called "norm of living"). The Committee recommends the use of the term "level of living" for the concept with which their report is primarily concerned. Its second task was to analyse the level of living into its components since in its view there is no single index that can be devised to measure differences in levels of living in different countries and no type of monetary index could be recommended. The Committee enumerates twelve "components" of the level of living representing generally recognized values—these are (in brief) health, diet, education, conditions of work, employment and unemployment, savings, transport, housing, clothing, recreation, social security and human freedoms. For the first seven of these, the Committee proposes a set of "indicators". Thus the health component is indicated by expectation of life at birth, the crude death rate, infant mortality rate, hospital beds and physicians (the last two in relation to population).

Although no single unified index was considered possible or desirable, the Committee proposes the use of certain indicators, described as "synthetic", "which while subject to great limitations provide in some measure for broad general comparisons of levels of living". These are (1) a series of macro-economic items related to national income (e.g., steel and coal supply; percentage of national income, (*a*) saved, (*b*) spent on basic needs of life; productivity of main crops); (2) an index

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of change in *per capita* income; and (3) the expectation of life at various ages. The Committee rejects the use of national income data expressed in a common currency unit as a satisfactory indicator for international comparisons and states "the publication by the United Nations of statistics of national incomes of different countries expressed in terms of the dollar has led to somewhat distorted inferences regarding the differences in levels of living in different parts of the World". The Committee recognizes that its list of indicators is somewhat numerous and that it may be difficult to have them treated adequately within a reasonably short time. It therefore proposes eight "priority indicators" viz. (in brief), expectation of life at birth; infant mortality; food supplies in terms of calories compared with requirements; school enrolment; literacy; unemployment; industrial distribution of population; and personal consumption as proportion of national income, together with the three synthetic indicators mentioned above.

Even an analysis of all the indicators proposed would not, in the Committee's view, provide an adequate picture of the level of living without "*direct and comprehensive measurement* of actual family living conditions" as shown by "family living surveys".

The Committee concludes its report with a series of recommendations for improving existing data, notably through the improvement of national statistical systems, the tabulation of the data of the population censuses in and around 1950 in such a way as to obtain significant information on levels of living, and the use of modern sampling survey methods. In its clarification of the concept "standard of living", its analysis of the problem of measuring levels of living and its enumeration of the data for use as indicators of these levels, the Committee has performed a valuable and much-needed task, and its report should be of great use to governments and private agencies interested in this subject.

J. W. NIXON.

13.—*The Trend of Government Activity in the United States since* 1900. By Solomon Fabricant assisted by Robert E. Lipsey. New York: National Bureau of Economic Research, 1952. xix + 267 pp. 9″. $4.00.

This is primarily a statistical account of the Government sector in the United States economy and of its growth in the past fifty years. "Government" comprises all Federal, State and local government agencies, including trading enterprises—broadly what is described in the British national accounts as the public authorities' sector. The statistics carry us from 1900 to 1949 (although in some cases they do not go beyond the early 1940's). The book is descriptive rather than analytical. Dr. Fabricant treats a most controversial subject in a most uncontroversial manner. He mentions, but barely discusses, the more lively topics which might be expected to arise—either political (whether the economic activity of government is a help or a hindrance to the growth of the economy) or theoretical (how far government activities are to be regarded as final goods and services, how far as intermediate products).

There is, however, much fascinating material on the composition of government expenditure, divided under functional headings and under the economically significant categories normally used in national accounting (but rarely found in the basic material of government accounting). The necessary rearrangement of the official accounts must have cost much labour. The summary measures of the growth of American Government from 1900 to 1949 are: the number of government employees rose 6-fold (4- or 5-fold, if defence be excluded); purchases from the private sector, at constant prices, rose 12-fold (5- or 6-fold, if defence be excluded); the capital assets of government, at constant prices, rose at least 6-fold (4-fold, if defence be excluded). A weighted average of these inputs shows at least an 8-fold expansion of government activity in fifty years (5-fold excluding defence), while the total real output and wealth of the nation approximately doubled. The government's share of the annual input of labour and capital increased from 5 per cent. to 14 per cent. of the total national input of resources—most of this increase having occurred by 1940.

It is, however, extremely difficult to determine, from the statistics which Dr. Fabricant gives, of what this vast increase in Government activity consisted. It was not, to any great extent, due to the spread of government enterprise into profit-making industry. The natural growth in the utility services provided by government contributes to the expansion, but not, it appears, at the expense of private enterprise. Among the major utility services which are normally in public ownership in Europe, only water supply is predominantly in public ownership in the United States; not only are the telegraph and telephones privately owned, but 80 per cent. of urban transport and 90 per cent. of urban electricity and gas supply are in private hands.

Apart from the expansion in the Forces and in their provision, the greater part of the increase in government expenditure on goods and services appears from Dr. Fabricant's tables to consist in expenditure on highways, the conservation and development of natural resources, education and public welfare services. Taking all levels of government together and combining current and

GC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

capital expenditure, it appears, for example, that in the late 1940's the amount spent on highways (about $3 billion a year) approached the amount spent on schools (presumably something like $4 billion; but the exact amount is unascertainable because the smaller local governments account for most expenditure on schools, and it seems that no summarized figures later than 1942 are available). But whether these deductions from the tables in the book are correct is highly uncertain, because Dr. Fabricant, while giving such figures as exist for expenditure at each level of government, does not make clear how far there may be duplication in the form of grants from one level of government to another. If true, the figures are in striking contrast to those for the United Kingdom; in 1952 expenditure on education by central and local government was just over £400 million—not too far below the United States figures per head—while expenditure on roads was less than £100 million.

The attempted comparison, however, illustrates the problems of dealing with the American statistics. However good at the Federal or State level, it appears that they are seriously deficient at lower levels of government; for systematic and up-to-date analysis, in detail, of Government activity, the U.S. statistician is much worse off (admittedly the difficulties of tabulation are much greater) than his British colleagues.

The appendices to the book incidentally provide an admirable reference source to the maze of statistics of U.S. government, and to the various analyses, both historical and current, made officially and unofficially. The appendices on Government employment statistics and on expenditure statistics (the latter by R. E. Lipsey) are of special interest.

Dr. Fabricant measures government expenditure, in real terms, simply by deflating actual expenditure by price indices; payrolls are deflated by earnings per head, purchases by combining existing price indices. He does not, however, discuss the possibilities of measuring real government output in a different way—by a weighted combination of physical units or "end-products" in the form of miles of highway, number of school-places, hospital beds, court cases, etc., as suggested by Reddaway (*J. R. Statist. Soc.*, Series A, Vol. CXIII, Part IV). It is true that most government activity is incapable of measurement on these lines (most general administration, for instance). Nevertheless, even a partial measure of this sort would be useful to give additional significance to the figures of deflated expenditure. There is a brief discussion, too, of the changes in "productivity" of government employees—chiefly in terms of hours of work. Thus it is interesting to find that the standard week in Washington, 39 hours in 1950, was not substantially different in 1900. Again, some analysis in terms of "end-products" per employee might be more illuminating.

The most interesting piece of statistical analysis in the book is a multiple correlation of inter-State variations in State and local government expenditure per head of population, with income (i.e., personal income per head), urbanization and density. The conclusion reached is that income is the major factor; although income is itself connected with urbanization and density, yet the direct association of the last two factors with expenditure is not marked. A striking fact in this connection is the remarkably wide variation of teachers' salaries between the States, which is associated closely with the variations in total income per head. In the U.S., teachers share in the regional differences of general prosperity, but there is no comparable difference between States in the "amount" of education, as measured by the ratio of teacher to pupils; the latter ratio has a very low elasticity with respect to income per head.

The book is a mine of information, but one could wish that rather more had been brought to the surface in finished form.

C. T. SAUNDERS.

14.—*International Insurance Transactions: Insurances in the Balances-of-Payments.* By S. J. Lengyel. University of Melbourne, 1953. (London: Wadley & Ginn). 139 pp. 9½″. 55*s*.

This appears to be the first general review of the importance of insurance in international transactions. Most of the book is a country-by-country analysis of the statistics relating to international insurance transactions. Mr. Lengyel severely criticizes both the scantiness of the published statistics and the inadequacy of the methods by which they are compiled. A glance through the 1950/51 edition of the International Monetary Fund's *Balance of Payments Yearbook* in fact shows that out of 65 countries, the Fund was able to get figures of international insurance transactions for 47. But some of these figures represent simply remittances, whereas Mr. Lengyel rightly says that the correct figures to be used (except perhaps in the more complex case of life insurance), should be premiums and claims payable, whether or not actual remittances crossed the exchanges. In other cases, the figures represent simply a given percentage of merchandise trade and refer only to insurance of cargoes, omitting transactions in insurance of other kinds. Moreover it is true, as Mr. Lengyel says, that no separate figures for insurance are given by the only two countries likely to be in substantial credit on current account in this field—the United Kingdom and Switzerland.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Among other countries with a large volume of international transactions in insurance, Denmark, Italy, the Netherlands, Norway, New Zealand and possibly (although not in 1950) France, approximately balance their payments and receipts; the rest (including the United States) are net debtors. Although the insurance figures for the United Kingdom are not separately published in the balance of payment statistics, they are included in an omnibus item. Mr. Lengyel pays a tribute to the method employed by the Board of Trade in its pre-war estimates of the United Kingdom balance of payments (as described in the *Board of Trade Journal* for May 5, 1939); the estimates were then obtained by special returns from insurance companies and brokers. Interest and dividends on funds invested abroad were in those days treated separately as "investment income".

Mr. Lengyel is severely critical of the inappropriateness of many existing estimates. "I know of no country", he writes, "where so much as an attempt has been made to estimate the effect of all such transactions on the balance of payments on a proper basis". This inadequacy, which leads most often to the use of statistics of remittances for balance of payments purposes, springs partly from the absence of a separation of foreign from domestic non-life business in the accounts of insurance companies and partly, in his view, from the inappropriateness, and particularly the excessive caution, of insurance accounting in general (on which he has written elsewhere). It is difficult to tell how much weight to attach to the practical effect of these failings. For non-life business, a statement of premiums and claims, and of foreign expenses, should be adequate, and this is what the *Balance of Payments Manual* recommends (although the Manual does not specifically recommend that the figures should be amounts payable or receivable, as Mr. Lengyel would have them, rather than actual payments or receipts). The treatment of investment income, and especially of undistributed profits, presents difficulties, but these are not confined to the transactions of insurance companies. International life business is admittedly more complex, but is probably conducted, for the most part, through branches or subsidiaries in the foreign country; these branches are not generally treated as residents of the country in which the head office is located. The main problem here is how to treat the income derived from the life funds; should this income be regarded as "imputed" income of the insured non-residents, or as accruing to the country in which the head office of the company is located?

Mr. Lengyel also criticizes the *Balance of Payments Manual* for excluding from international transactions business done by residents with the local branches of foreign companies. Certainly this is, in a broad sense, "international" business. But for a consistent scheme of balance of payments statistics, a consistent definition of "residents" must be applied. To treat all business with branches of foreign companies operating in say the United Kingdom, as "international transactions" of the United Kingdom, would create fairly serious problems.

Mr. Lengyel has much of value to say on both the foreign and domestic business of insurance in various countries. He notes particularly the growth of economic nationalism in this field, most marked in Latin America where foreign insurance business has been largely squeezed out. The British Commonwealth remains the only international area within which insurance is reasonably free.

C. T. SAUNDERS.

15.—*How to Lie with Statistics.* By Darrell Huff. London, Gollancz, 1954. 142 pp. 7½″ 10*s.* 6*d.*

On the cover, there appears the caption "An independent survey made by the publishers shows that this book has more sound information (and more laughs) per page than any other book of the same title". For once, this would appear to be a meiosis. "The pretty little instances of bumbling and chicanery," says the author, "with which this book is peppered have been gathered widely and not without assistance. Following an appeal of mine through the American Statistical Association, a number of professional statisticians—who, believe me, deplore the misuse of statistics as heartily as any one alive—sent me items from their own collections".

While most of the instances given suggest deliberate dishonesty, sometimes it is quite unconscious. In spite or perhaps because of the frivolous style in which the book is written and the 86 comic pictures by Irving Geis it will tell, not only the general public much more, but quite a number of serious students of statistics a good deal more, than they know of the many fallacies which beset statistical interpretation. The first chapter is called "The Sample with the Built-in Bias", the fifth "The Gee-Whiz Graph", and the tenth "How to talk back to a Statistic". The last chapter has headings "Who Says So?", "How Does He Know?", "Did Somebody Change the Subject?", "Does it Make Sense?". This is sufficient to show the spirit in which the work is written and its purpose is successfully accomplished.

When somebody referred to the quip, attributed to Disraeli, about "Lies, Damned Lies and Statistics", Karl Pearson used to say, "It's not that figures lie, but that liars sometimes figure". To this conclusion there will be no serious dissent.

J. O. IRWIN.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices published by the Ministry of Labour and National Service rose from 141 (prices at June 17th, 1947 = 100) in May to 142 in June and to 145 in July. The increase in June was mainly due to rises in the prices of some kinds of vegetables and fruit and of coal in London and the South of England. By mid-July there had been increases in the prices of meat, eggs and potatoes. Separate figures on the same basis (i.e. June, 1947 = 100) are not available for the different groups of commodities, but the following are the figures based on January 15th, 1952 = 100.

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Alcoholic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
May 18th, 1954	112·1	111·7	96·3	109·6	95·2	100·1	109·9	101·4	100·3	106·7
June 15th, 1954	113·6	111·9	96·3	110·0	95·2	100·1	110·4	101·4	100·3	107·3
July 13th, 1954	118·0	112·0	96·3	110·2	95·1	100·1	110·2	101·6	100·3	109·1

The Ministry of Labour index of weekly wage rates, which was 142 in May (June 30th, 1947 = 100) remained at that figure in June and July. There were increases in wage rates in the printing and furniture trades and in iron and steel and boot and shoe manufacture during this period but these were insufficient to affect the index figure to the nearest whole number.

The total working population and the numbers in civil employment in the three months ended June, 1954, were as follows:

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
April, 1954 . .	15,923	7,557	23,480	14,913	7,431	22,344
May, 1954 . .	15,928	7,590	23,518	14,948	7,482	22,430
June, 1954 . .	15,921	7,610	23,531	14,954	7,512	22,466

The number of persons on the unemployment registers of the Employment Exchanges fell by 50,000 between May and June and by a further 20,000 in the following month. The total of 220,133 at July, 1954, represented 1·0 per cent. of the estimated total employees in Great Britain. The percentage in the separate Regions ranged from 0·5 in the Midlands and North-Midlands to 1·8 in Northern, 2·3 in Scotland and 2·1 in Wales.

The following is a sex analysis of the figures:

Numbers of Unemployed Persons on the Registers of Employment Exchanges

1954	*Men and Boys*	*Women and Girls*	*Total*
May 10th	184,701	104,725	289,426
June 14th	156,032	83,489	239,521
July 12th	143,586	76,547	220,133

Of the total of 220,133 at July 12th, 60,886 had been unemployed for not more than two weeks, 46,512 for two to eight weeks and 101,423 for over eight weeks, while 11,312 were temporarily stopped.

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed were 904,100 in May, 885,600 in June and 817,600 in July. The numbers of employed persons absent owing to industrial injuries were 59,400, 58,000 and 54,900.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(2) OTHER STATISTICS

The series of World Health Organization publications entitled *Annual Epidemiological and Vital Statistics* is a continuation of a corresponding series of League of Nations publications before the second World War. The two earlier issues contained statistics for the years 1939 to 1946 and 1947 to 1949. The arrears have now been caught up and each issue will henceforth cover a single year only.

Part I, *Vital Statistics and Causes of Death* (Geneva, 1953), contains information of deaths in 1950 from upwards of thirty different countries. There are no retrospective series for earlier years. Apart from the usual basic tabulations of area, population, births, marriages and deaths (giving both the actual numbers and appropriate rates) there are more detailed analyses of particular value to demographers, such as age-specific mortality rates, and fertility rates according to the age of mother; there is also a section on life tables. The bulk of the volume, however, consists of analyses of the deaths in each country by medical cause, age and sex. The year 1950 was a transition year from one international classification of the causes of death to another, and some countries were still using the old classification. (A few were still using a national grouping of causes.) This hampers international comparisons for 1950 but is unlikely to be important in later years. There are, in addition, special tabulations of the causes of deaths of children under 5 years and of deaths from malignant neoplasms, and from tuberculosis, by site. The recent changes in mortality from pulmonary tuberculosis in selected countries are sketched in an annex.

Part II, *Cases of and Deaths from Notifiable Diseases* (Geneva, 1954), contains data on the notifications of 35 communicable diseases in 1950 in a large number of countries and territories throughout the world. For most of the diseases the numbers of cases notified to health authorities, and the deaths, are tabulated by monthly or four-weekly periods throughout the year. For diseases with no pronounced seasonal pattern annual figures only are given. It is well known that, for a variety of reasons, notified cases represent only a fraction of the actual cases and hence no attempt has been made to calculate morbidity rates. Nevertheless the published figures act as a guide and to a considerable extent indicate seasonal and annual variations in particular diseases in a given country.

Censuses of the non-native populations of Kenya Colony and Protectorate, Tanganyika and Uganda were taken on the night of February 25th, 1948. The reports of these enumerations were published in 1953 and are the work of C. J. Martin, the Director of Statistics, East Africa, who was made responsible for the planning and analysis of each census. Each of these operations has been documented in a workmanlike manner with a statement of reasons for choice of date and methods, and a commentary supported by diagrams bringing out the salient features of the population structure. The commentaries each include a useful summary (an all too frequent omission from census reports) and a statement of further research to be undertaken. These reports will be of considerable interest to students as well as to demographers of mature standing.

The co-operation of many organizations and individuals had made it possible for the Timber Development Association to present both published and hitherto unpublished information in considerable detail in the 1953 edition of its Yearbook (*T.D.A. Year Book of Timber Statistics*, 1953, 3rd ed., June 1954). The tables, to which are appended full explanatory notes, cover exports, imports, consumption and stocks, so that users have a compact reference book on all aspects of the trade.

Fellows of the Society will welcome the appearance the of new *International Journal of Abstracts on Statistical Methods in Industry*. This new series of abstracts is published by the International Statistical Institute (The Hague: Price U.S. $2.50) and at present will appear three times a year with about 100 abstracts in each issue. These abstracts, which are collected by regional editors, are under the general editorship of Dr. Grant I. Butterbaugh and the whole project is under the auspices of the I.S.I. Committee on Statistics in Industry and Technology (see *Review of the International Statistical Institute*, Vol. 21, 1953, page 106).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The format is attractive in that the abstracts are printed on one side of thin cardboard—three to a page 3″ × 5″—which can be cut to form a card index system. Abstracts, which are in English or French, are temporarily classified under five headings and are intended to cover a fairly broad field centred upon applications of statistical methods to problems of industrial production, quality control and statistics for management. In this context the term "industry" will be interpreted to include e.g., transport, mining and electric power generation. Where appropriate some theoretical papers that have direct applications in these fields will also be included.

CURRENT NOTE

The Trustees of the Houblon-Norman Fund invite applications for Fellowships or Grants in aid of Research into the working of industry and finance in Great Britain and elsewhere and the economic conditions affecting them.

Fellowships, which are intended for experienced research workers, are awarded for full-time research for one year, which may be renewed for a second year. Grants are awarded for either full-time or part-time work. The amount of the awards, which will take effect from the 1st October, 1955, will depend upon the circumstances of the candidate and the probable expenses of his work.

Candidates must be British subjects normally resident in the United Kingdom.

Forms of application, which may be obtained from the Secretary of the Fund, c/o the Bank of England, London, E.C.2, should be returned not later than March 31st.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

OBITUARY.

Sir Henry Clay

Sir Henry Clay died in hospital in Middelburg in Holland, where he was on holiday, after a road accident on July 30th, 1954.

His death will be deeply regretted by his many friends in the Society. He always had a keen interest in statistical questions. He became a Fellow of the Society in 1924, and when he moved to London in 1930 he was able to take a more active part in the work of the Society. He was a member of the Council for eleven years between 1931 and 1951 and was a Vice-President on four occasions. He only ceased to be a member of the Council after he retired from the post of Warden of Nuffield College, Oxford.

Henry Clay was born in Bradford in 1883 and went from the local grammar school to University College, Oxford, and it was there that his interest in the economic and social studies developed. After leaving Oxford he became Warden of the Neighbour Guild Settlement in Sheffield for two years and then from 1909 until the first world war, he lectured to University tutorial classes, mainly in Lancashire and Yorkshire, under the Workers' Educational Scheme. It was this experience of talking to members of these classes that urged him to write his *Economics for the General Reader*, appropriately inscribed "To Albert Mansbridge", the founder of the Workers' Educational Association. The aim of the book was to explain the principles of the working of the economic organization of the country in the language of ordinary life and with reference to the experience and interests of the ordinary man, so that the general reader could perceive the bearing of economic studies on the political and social problems. It went further, and discussed the relationship of economic organization to political and ethical aims and standards. It was Clay's view that "economics would gain rather than lose in authority by discarding its mid-Victorian pose of being the one and only science of society". His book was for many years the best of its kind and, thirty years later, was still being reprinted.

The first world war brought a change in his career and in his interests. He joined the Ministry of Labour as a temporary civil servant and was later responsible for writing part of the official history of the Ministry relating to labour questions during the war. He became a Fellow of New College, Oxford, from 1919 to 1921 and then in 1922 became Stanley Jevons Professor of Political Economy in Manchester, where he stayed until 1930.

Most of his writings in the early years of the 1920's were concerned with the problems of industrial relations. The difficulties of the post-war years had dispelled the notion that industrial disputes were the private affair of the parties engaged in them. The growing realization of the public interests involved made Clay seek to determine what these interests were and how the Government should intervene in trade disputes. Some of his essays and lectures for this period were subsequently collected and published in *The Problems of Industrial Relations and other Lectures.*

When this book appeared in 1929 it was obvious that his own interest had already begun to move from the narrower problems of industrial relations to the more general questions of discussing what were the functions of the State in economic and social matters. Among the lectures reprinted in his book were those on "The Authoritarian Element in Distribution" and "Property and Inheritance".

In the same year, 1929, Clay also published his book on *The Post-War Unemployment Problem* where he carried his analysis of the unemployment problem of the post-war years into a discussion of the policies which public and private enterprise might pursue to revive the depressed areas and to restore the competitive position of British industries. The effect of publication of this book was to bring a change in his career. Montagu Norman, the Governor of the Bank of England, invited him to take an appointment on the Securities Management Trust, a subsidiary set up by the Bank to give financial assistance in industrial reorganization. His job was to undertake economic research into the problems of British industry and this appointment was followed two years later by his becoming Economic Adviser to the Bank of England. From then onwards he was the confidant of Montagu Norman and his influence grew, but from the point of view of the public it meant that his writings ceased. There is no doubt that he had a great personal affection for Montagu Norman and at the time of his death Clay was engaged in writing a biography of Norman.

In the summer of 1939, at the request of the Government, Clay joined Lord Stamp and Hubert Henderson to make up a three-man team to survey the economic and financial plans for war. The "Stamp Survey" was very active in the months before and after the outbreak of the war

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and Clay was devoting a large amount of time to this official work throughout 1939 and 1940. When the work of the Stamp Survey ceased in 1941, Clay was asked to become Economic Adviser to the Board of Trade to study post-war reconstruction problems.

In 1944 Clay resigned his post with the Bank of England and became Warden of Nuffield College, Oxford. The work on the development of the College had been suspended during the war and it was his task, not only to go ahead with the plans for the building of the College, but to recruit the first members of the new College. In this work he was extremely happy and he was Warden until 1949 when he retired. Even then he still kept his interest in economic and statistical questions and continued to serve as Chairman of the Executive Committee of the National Institute of Economic and Social Research.

Henry Clay was a man of great charm and he had a wide circle of friends. His writings were lucid and much more forceful than might be expected from casual conversations with him. Although he himself did not claim to be a statistician he had a flair for knowing the kinds of subjects worth investigation. For many years he was a stimulating influence in the development of research in economic questions and there must be many economists and statisticians who will always be grateful to him for his kindly personal interest in them and the help he so willingly gave them.

A. M. Southall

The death early this year of Mr. Arthur M. Southall was noticed with much regret, particularly by those Fellows who knew him as an active member of the Study Group (as it then was) before the war. His association with the Society will be well and long remembered by those of us, now in middle age, who, some 25 years or so ago, helped to found the Study Group. Arthur Southall was one of the most active and enthusiastic members of that small company and gave to it much of his time and effort. He became the Secretary and, in 1938, the Chairman of the Group. In those early years it was the custom to meet from time to time with the Institute of Actuaries Students' Society and on such occasions Southall did valiant work for the Study Group. His several papers, and his more frequent participation in discussion, contributed greatly to the work of the Group and he fully shared with others of us the pleasure of seeing it develop after the war into the vigorous and sturdy Study Section that it now is.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

British Journal of Preventive and Social Medicine—

July 1954—A study of two years' work in Northern Ireland general practice: *J. C. C. Crawford.* Recent trends in survival of patients with respiratory tuberculosis: *C. R. Lowe.* Body-weight of men related to stature, age and social status: *E. M. B. Clements* and *K. G. Pickett.* Chest girth of men related to stature, age, body-weight and social status: *E. M. B. Clements* and *K. G. Pickett.* Heterospecific pregnancy: *J. M. Johnstone.* Sex ratio and the ABO blood group system: *J. M. Johnstone.* Social class variations in mortality: *W. P. D. Logan.*

British Journal of Sociology—

June 1954—Measuring poverty: *P. Townsend.* Prestige ranking of occupations in an American city with reference to Hall's and Jones's study: *J. B. Montague* and *B. Pustilnik.*

Institute of Actuaries Students' Society, Journal—

July 1954—The wider field: *F. H. Spratling.* Further remarks on the wider field: *F. A. A. Menzler.*

Oxford University Institute of Statistics, Bulletin—

May–June 1954—Retrospect and prospect: the Economic Survey, 1954: *P. D. Henderson.* The "courbe des populations", a further analysis: *G. R. Allen.* The limitations of the short term consumption function: *T. Balogh.*

Royal Society of Edinburgh, Proceedings, Section A—

Vol. LXIV, Part I—Asymptotic renewal theorems: *W. L. Smith.*

AUSTRALIA—

Economic Record—

May 1954—Input-output analysis: *B. Cameron.* An index of Australian manufacturing production: *S. P. Stevens.* Labour turnover in New Zealand industries: *G. P. Braal.*

INDIA—

Sankhyā—

June 1954—A theory of estimation for the fundamental random process and the Ornstein Uhlenbeck process: *H. B. Mann.* On the efficiency of the least square estimates of parameters in the Ornstein Uhlenbeck process: *H. B. Mann* and *P. B. Moranda.* On some characterizations of the normal distribution: *D. Basu* and *R. G. Laha.* On the optimum character of some estimators used in multistage sampling problems: *D. Basu.* On the confluent hypergeometric function $M(\alpha, \gamma, x)$: *S. Rushton.* Tables of the confluent hypergeometric function: *S. Rushton* and *E. D. Lang.* Estimation of national consumption of the United Kingdom from family budgets studies: *M. Mukherjee.* An adjustment for the effect of changing birth rates on infant mortality rates: *K. K. Mathen* and *S. J. Poti.* Seasonality in the incidence of strikes in the Bombay textile industry: *R. K. Som.*

UNITED STATES—

American Statistical Association, Journal—

June 1954—Measurement for economic models: *S. Lebergott.* Technical aspects of transportation flow data: *R. Tynes Smith.* Response errors in the collection of wage statistics by mail questionnaire: *S. E. Cohen* and *B. Lipstein.* Industrial classes in the United States, 1870 to 1950: *T. M. Sogge.* Statistical methods for Poisson processes and exponential populations: *A. Birnbaum.* Applications of the circular normal distribution: *E. J. Gumbel.* A new type of control chart limits for means, ranges, and sequential runs: *H. Weiler.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

American Statistician—

June–July 1954—Operations research as a science: *J. B. Lathrop.* Recent revisions of consumer credit statistics: *H. Jones.* Limitations of consumer credit statistics: *E. A. Daver.* Report of the *Ad Hoc* Committee on Statistical Standards.

Biometrics—

June 1954—Further studies on the significance of family factors for the response to BCG vaccination: the development of local vaccination lesions and their relation to allergy production: *S. V. Meyer* and *M. W. Bentzon.* Estimation of relative potency from multiple response data: *C. R. Rao.* Error of the determination of the eosinophil count in peritoneal fluid of the rat: *P. B. Dews, G. M. Higgins* and *J. Berkson.* How many organisms?: *J. Worcester.* The analysis of variance of diallel tables: *B. I. Hayman.* A confidence interval for a percentage increase: *I. Bross.* Chain block designs with two-way elimination of heterogeneity: *J. Mandel.* Analysis for some partially balanced incomplete block designs having a missing block: *M. Zelen.* The use of coveriance to control gradients in experiments: *W. T. Federer* and *C. S. Schlottfeldt.* Design and analysis of soil insecticide field experiments: *D. van der Reyden.*

Econometrica—

July 1954—Existence of an equilibrium for a competitive economy: *K. J. Arrow* and *G. Debreu.* An application of activity analysis to the theory of the firm: *M. J. Farrell.* A note on Mr. Farrell's model: *D. G. Champernowne.* Inventory fluctuations in flaxseed and linseed oil, 1926–1939: *S. G. Allen.* Price determination in a stock-flow economy: *R. W. Clower* and *D. W. Bushaw.* Effects on demand of changes in the distribution of income: a comment: *W. J. Corlett.* Effects on demand of changes in the distribution of income: a reply: *K. Borch.* Quasi-inverses associated with Minkowski-Leontief matrices: *Y. K. Wong.* Stability of the exchange rate mechanism in a multi-country system: *J. J. Polak* and *Ta-Chung Liu.*

Journal of Political Economy—

June 1954—The Malenkov-Khrushchev new economic policy: *L. Volin.*

Operations Research Society of America, Journal—

May 1954—Traffic delays at toll booths: *L. C. Edie.* The influence of servicing times in queueing processes: *D. P. Gaver.* Application of transportation theory to scheduling a military tanker fleet: *M. M. Flood.* A verification of Lanchester's Law: *J. H. Engel.* An approximate measure of value: *C. W. Churchman* and *R. L. Ackoff.* Organization and information handling in task groups: *L. S. Christie.* Optimum preventative sampling: *P. Whittle.*

August 1954—Threats to the growth of operations research in business and industry: *R. F. Rinehart.* Observations on operations research: *M. L. Hurni.* Mathematical foundations and computational methods for a digital logic machine: *R. S. Ledley.* Some applications of the theory of dynamic programming—a review: *R. Bellman.* The control of inventory and production rates—a survey: *H. A. Simon* and *C. C. Holt.* The effect of reliability of "supervisory" equipment on the accuracy of a "supervised" system: *A. W. Boldyreff.* Feasibility considerations in the allocation of resources to military programs: *F. P. Hoeber* and *A. Karchere.* Parametric objective function (Part 1): *T. Saaty* and *S. Gass.* Information theory and man-machine systems: *G. K. Krulee.* Erich Schneider's inventory control analysis: *T. M. Whitin.*

Psychometrika—

June 1954—Multivariate information transmission: *W. J. McGill.* A least squares solution for successive intervals assuming unequal standard deviations: *H. Gulliksen.* Some necessary conditions for common-factor analysis: *L. Guttman.* Note on "A table for the rapid determination of the tetrachoric correlation coefficient": *M. D. Davidoff.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Quarterly Journal of Economics—

May 1954—Recent developments in economics: *F. Zeuthen.* The balanced budget: *J. Burkhead.* Some economic aspects of fissionable material: *S. Enke.* Critical notes on the acceleration principle: *H. Neisser.* Location theory and trade theory: a short-run analysis: *W. Isard.*

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. VII, Parts 1 and 2—Vertrauensgrenzen eines Extremums: *A. Linder.* Verzerrung eines Stichprobenplanes durch Nichtbeantwortung: *H. Kellerer.* Einige statistische Modelle zur Analyse von Fussballresultaten: *S. Vajda.* Über den Umgang mit systematischen Fehlern: *O. Anderson.* Gangprufung bei normal verteilten Qualitätsmerkmalen: *A. Adam.* Bemerkungen zur statistischen Qualitätskontrolle in der Spinnerei: *J. Pfanzagl.* Mass und Richtung: Zur Aggregation drei wertiger Signalkonstellationen im Ifo-Konjunkturtestverfahren: *E. Fels.* Ein Beitrag zur mechanischen Ausgleichung: *L. Schmetterer.* Tabakkonsum und Erkrankungen der Atmungsorgane: *W. Ossadnik.*

DENMARK—

Nationaløkonomisk Tidsskrift—

Vol. 92, Parts 3–4—Input-output modellens anvendelsesmuligheder: *P. N. Rasmussen.* Udviklingen på det Danske penge-og kapitalmarked I årene 1948–1953: *H. S. Larsen.*

FRANCE—

Revue d'Économie Politique—

July–October 1954—La France économique en 1953. (Whole number.)

GERMANY

Mitteilungsblatt für Mathematische Statistik—

Vol. 6, Part 2—Die Extremwertkarte bei der laufenden Fabrikationskontrolle: *U. Graf* and *R. Wartmann.* Über die Streugrenzen statistischer Verteilungskirven: *H. Klein.* Elementäre Ableitung der Momente für die Zahl der Überschreitungen: *E. J. Gumbel.* Über die Ausnutzung der Irrtumswahrscheinlichkeit: *E. Walter.*

Weltwirtschaftliches Archiv—

Vol. 72, Part 2—The creation of money income: *J. Pedersen.* Die Tätigkeit der Reichsbank von 1876 bis 1914 II: *K. R. Bopp.* Zur Frage der Auswirkungen einer Abwertung auf die internationalen Austauschbedingungen: *K. Rothschild.*

HOLLAND—

Statistica—

Vol. 7, No. 4—Macht en onmacht van de statistiek: *J. Idenburg.* Waarneming en rationeel gedrag: *J. A. Hartog.* De verantwoordelijkheden van de statisticus: *D. van Dantzig.* Kwantificering in de sociale wetenschappen: *W. H. Somermeyer.* Kwantificering in medisch onderzoek: *L. Rümke.* Kwantificering in taal en crypto-analyse: *M. de Vries.*

ITALY—

Giornale degli Economisti e Annali di Economia—

May–June 1954—Luigi Einaudi storico delle dottrine economiche: *G. B. Pacini.* La demografia delle razze umane: *M. Boldrini.* Sulla direzionalità della curva di offerta individuale di lavoro: *R. Maggi.* I modelli esplorativi statistici e le ricerche di economia induttiva: *F. Brambilla.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Statistica—

April–June 1954—Punti di vista sugli studi per campione del mercato del lavoro: *A. Bellettini.* Sulla misura di alcuni aspetti della variazione nel tempo della concentrazione economica: *G. Cusimano.* Ancora sulla eliminazione degli iscritti agli uffici di collocamento ed altri problemi di statistica del lavoro: *R. Lenzi.* Alcuni osservazioni in materia di produttività: *L. Bergonzini.* Delle relazioni fra alcune costanti statistiche e la curva di concentrazione: *A. Bellettini.* Aspetti e tendenze del mercato cinematografico italiano: *A. Bellettini.*

JAPAN—

Faculty of Science, Kyusyu University, Memoirs (Series A)—

April 1953—Successive process of statistical inferences (5): *T. Kitagawa.*

Institute of Statistical Mathematics, Annals—

Vol. V, No. 2—On the estimation by the minimum distance method: *K. Matusita.* Note on Wiener's prediction theory: *K. Takano.* On the interviewing bias: *H. Aoyama.* On the solutions of certain simultaneous equations in the theory of systematic statistics: *I. Higuchi.* The effect of selection on linear functions of normally distributed correlated variables on the distributions of other linear functions: *G. A. Baker.* Tables for three-sample test: *Y. Hiraga, H. Morimura,* and *H. Watanabe.* Some further extension of Fieller's theorem: *B. M. Bennett.* On the polaron state: *T. Yokota.* Multidimensional quantification—with the applications to analysis of social phenomena: *C. Hayashi.*

Union of Japanese Scientists and Engineers (Reports of Statistical Application Research)

December 1953—Graphical method of statistical inference, Part IV. Mixing ratio of particles of two kinds: *M. Masuyama.* Graphical method of statistical inference. Part V. On a gamma distribution and related problems: *M. Masuyama.* On a convoluted Poisson process: *T. Homma.* Lineal combinations on a Mendelian inherited character: *Y. Komatu* and *H. Nishimiya.*

NORWAY—

Statistiske Meldinger—

Vol. 72, No. 8—Utvalget av personlige skattytere for skattestatistikken: *H. Amundsen.*

SPAIN—

Suplemento al Boletin de Estadistica—

No. 6 (1954)—El sistema de curvas de Pearson, integrado en el mas general de Quiquet: *A. Lasheras-Sanz.* Algunas ideas para el estudio del mercado bursátil: *A. Vegas.* El cálculo de los momentos factoriales en distribuciones discretas y la deducción de los potenciales a partir de aquéllos: *E. G. España.* Juegos de azar y juegos de estrategia y sus aplicaciones: *S. Ríos.* Aclaraciones al caso mas simple del Analisis de la varianza: *F. A. Poch* and *J. L. S. Crespo.* Sobrevisión por muestreo de una población Escolar: *J. L. S. C. Rodríguez.* Los procedimientos empiricos de muestro: *J. M. D. de la Rosa.* Automatización de métodos estatísticos: *F. F. de Bobadilla.* Valoración del analfabetismo en España: *A. G. Reina.* El desarrollo del cáncer en España: *J. M. Jadraque.*

Trabajos de Estadistica—

Vol. V, Part I—Superposición de variables aleatorias y sus aplicaciones: *P. Zoroa.* Le meilleur procédé pour l'inspection rectifiante d'un lot: *F. J. Anscombe.* Sobrevisión por muestro en la Universidad de Madrid: *J. Tena.* Orientaciones para la enseñanza de la Estadística en el Bachillerato: *A. G. Barbancho.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part 3, 1954, the Society has received the publications enumerated below.

I.—OFFICIAL

United Kingdom. *Board of Trade.* Census of distribution and other services 1950. Volume II: Retail and service trades, general tables. London, H.M.S.O., 1954. xiii, 330p. 12½″. 22*s.* 6*d.*

Exporting to the United States of America. rev. ed. London, H.M.S.O., 1954. 68p. map. 9½″. 3*s.* 6*d.*

Report to the President of the Board of Trade by the United Kingdom Industrial Delegation to Burma, March 1954 ... London, H.M.S.O., 1954. vii, 32p. 9½″. 2*s.* 6*d.*

Board of Trade. Ministry of Materials. Report of the matchwood working party. London, H.M.S.O., 1954. [ii], i, 26p. 13″. 2*s.*

General Register Office. The Registrar General's decennial supplement England and Wales, 1951. Occupational mortality Part I. Deaths in 1950 in certain broad groups of occupations related to population figures derived from the 1951 census one per cent sample tables. London, H.M.S.O., 1954. iv, 75p. 13″. 7*s.* 6*d.*

Census 1951 England and Wales: County report ... Buckinghamshire. xliii, 52p. 17*s.* 6*d.* Durham. xlvi, 88p. 22*s.* 6*d.* Glamorganshire. xlvi, 64p. 20*s.* Lancashire. li, 218p. 42*s.* Northumberland. xliv, 70p. 20*s.* Staffordshire. xlix, 91p. 25*s.* Sussex, lii, 95p. 25*s.* Warwickshire. xlv, 64p. 20*s.* Worcestershire. xlvii, 59p. 20*s.* London, H.M.S.O., 1954. 13″.

Medical Research Council. Air disinfection with ultra-violet irradiation: its effect on illness among school-children; by the Air Hygiene Committee. London, H.M.S.O., 1954. viii, 88p. plates. 9½″. 7*s.* (M.R.C. Spec. Rep. Ser. 283.)

Ministry of Agriculture and Fisheries. Report of the departmental committee on foot-and-mouth disease, 1952–1954 ... London, H.M.S.O., 1954. 151p. 9½″. 5*s.* 6*d.* Cmd. 9214.

Ministry of Health. Central Health Services Council: Report of the Committee on General Practice within the National Health Service. London, H.M.S.O., 1954. iv, 67p. 9½″. 2*s.* 6*d.*

Mortality and morbidity during the London fog of December 1952: report by a committee of departmental officers and expert advisers appointed by the Minister of Health. London, H.M.S.O., 1954. iv, 61p. 9½″. 2*s.* 6*d.* (Rep. on Publ. Hlth. & Med. Subj. 95.)

Office of the Lord President of the Council. The use of town's wastes in agriculture: a study by the Natural Resources (Technical) Committee, London, H.M.S.O., 1954. iv, 25p. 9½″. 1*s.* 3*d.*

Social Survey. Labour mobility in Great Britain, 1945–1949; by Geoffrey Thomas: an inquiry carried out for the Ministry of Labour and National Service. [London, Central Office of Information, 1949.] ii, 69, 12p. (typewritten). 13″.

The proportion of jurors as an index of the economic status of a district; P. G. Gray, T. Corlett and Pamela Jones. London, Central Office of Information, 1951. 8p. (typewritten). 13″.

Some results of a survey made for the Committee on General Practice of the Central Health Services Council. Choosing and changing doctors and Who gets the medicine; P. G. Gray ... and Ann Cartwright ... 17p. (typewritten). 8¾″.

The uptake of welfare foods; by J. E. Fothergill. Report of an inquiry carried out by the Social Survey in April, 1951 for the Ministry of Food. London, Central Office of Information, 1951. iv, 46p. (typewritten). 13″.

Royal Commission on the Taxation of Profits and Income. Second report ... London, H.M.S.O., 1954. x, 125p. 9½″. 4*s.* 6*d.* Cmd. 9105.

Scotland. Department of Agriculture. Report of the Commission of Enquiry into Crofting Conditions ... Edinburgh, H.M.S.O., 1954. 100p. 9½″. 3*s.* 6*d.* Cmd. 9091.

Scotland. General Registry Office. Census 1951: report on the fifteenth census of Scotland. ... Vol. I.—Part 11. County of Bute. 32p. 7*s.* 6*d.* Part 21. County of Lanark. 54p. 12*s.* 6*d.* Part 22. County of Midlothian. 42p. 10*s.* Part 23. Counties of Moray and Nairn. 66p. 15*s.* Part 24. County of Orkney. 37p. 8*s.* 6*d.* Part 25. County of Peebles. 32p. 7*s.* 6*d.* Edinburgh, H.M.S.O., 1953–54. 13″.

Treasury. Committee on departmental records: report ... London, H.M.S.O., 1954. 88p. 9½″. 3*s.* Cmd. 9163.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Argentina. *Ministry of Foreign Affairs and Worship.* Economic possibilities in the new Argentina: investment of foreign capital. Buenos Aires, 1953. 39, [3]p. 9¼″.

Australia. *Bureau of Agricultural Economics.* Australian clothing consumption survey: general report ... Canberra, 1954. ii, 82p. 9¾″.

Brasil. *Instituto Brasileiro de Geografia e Estatística.* Recenseamento geral do Brasil (1 de Setembro de 1940) Série regional. Parte VI, IX–XXII. Rio de Janeiro, 1950–1952. 14 vols. 10¾″.

Serviço Nacional de Recenseamento. Recenseamento geral do Brasil 1950: Sinopse preliminar do censo industrial. Rio de Janeiro, 1953. xiv, 183p. 10¾″.

VI Recenseamento geral do Brasil. Censo demográfico (1 de Julho de 1950). Estados unidos do Brasil, seleção dos principais dados. Rio de Janeiro, 1953. xii, 85p. 10¾″.

" Selected tables of the population census. Tableaux choisis du recenseamento de la population. Rio de Janeiro, 1953. vii, 15p. 10¾″.

France. *Institut National de la Statistique et des Études Économiques.* Nomenclature des métiers et des activités individuelles (édition nouvelle) Index alphabétique. Index analytique. Paris, 1954. 2 vols. 10½″.

Germany. *Statistiches Bundesamt.* Die Wahl zum 2 Deutschen Bundestag am 6 September 1953. Heft 1: Allgemeine Wahlergebnisse nach Landern und Wahlkreisen. Stuttgart-Koln, W. Kohlhammer, 1954. 89p. 11¾″. (Statistik der Bundesrepublik Deutschland Bd. 100.)

India. *Office of the Registrar General.* Census of India 1951: Age tables. New Delhi, 1954. ii, 172p. 11″. 3*s*. (Census Paper 3.)

Malaya. Federation of Malaya annual report, 1953. London, H.M.S.O., 1954. xv, 392p. 8½″. 10*s*. 6*d*.

Nigeria. *Department of Commerce and Industry.* Handbook of commerce and industry in Nigeria. 2nd ed. Lagos, 1954. 189p. 9½″. 6*s*.

Organisation for European Economic Co-operation. Statistics of national product and expenditure, 1938, 1947 and 1952. Paris, O.E.E.C., 1954 (London, H.M.S.O.). 310p. 4 fol. tabs. 11¾″. 14*s*.

Southern Rhodesia. *Central African Statistical Office.* Preliminary report on the second demographic survey of the indigenous African population of Southern Rhodesia. Salisbury, 1954. iv, 12p. 13″.

Report on the 1950 demographic sample survey of the African population of Northern Rhodesia. Salisbury, 1954. [v], 43p. 13″.

Sweden. *Statistiska Centralbryån.* Folkräkningen den 31 December 1945 ... VII, 2. Partiella undersökningar (tolvtedelssamplingen) Behandlar delar av familjestatistiken. 1954. xii, 77, 38p. 9½″. xI. Redogorelse for ratabellernas innehall M. M. Stockholm, 1954. xi, 8, 363p. 9½″. (Sveriges Officiella Statistik.)

Folkräkningen den 31 December 1950: III. Totala räkningen folkmängden ålder och kön i kommuner församlingar och tätorter. Stockholm, 1954. vii, 6, 317p. 9½″. (Sveriges Officiella Statistik.)

Switzerland. *Eidgenossisches Statistiches Amt.* Eidgenössische Volkszählung 1 Dezember 1950. 2. Kanton Aargau. 152p. 15. Kanton Solothurn. 138p. 21. Canton de Vaud. 257p. Bern, 1954. 3 vols. 11¾″. (Statistiche Quellenwerke, 255, 254, 253.)

United Nations. *General Agreement of Tariffs and Trade.* International trade 1953. Geneva, G.A.T.T., 1954. 141 [4]p. 9½″. $1.50.

United States of America. *National Bureau of Standards.* Probability tables for the analysis of extreme-value data. Washington. Supt. of Documents, 1953. iii, 32p. 10¼″. 25*c*. (Appl. Math. Ser. 22.)

Statistical theory of extreme values and some practical applications: a series of lectures by Emil J. Gumbel, prepared for publication with the assistance of Julius Lieblein. Washington, Supt. of Documents, 1954. viii, 51p. 10¼″. 40*c*. (Appl. Math. Ser. 33.)

West Bengal. *Home (Publicity) Department.* Report on the working of the State Statistical Bureau for the years 1950–51, 1951–52 and 1952–53. Calcutta, 1954. 17, 17, 11p. 9¾″. 3*s*. 6*d*.

State Statistical Bureau. Statistical atlas of West Bengal; prepared by the State Statistical Bureau ... Calcutta, 1953. [ii], ii, 2p. 41 maps. 15″ × 11″. 6*s*. 9*d*.

Survey of unemployment in West Bengal, 1953 (First interim report) Vol. I part I. (Interim report) Vol. I part II. Calcutta, 1954. 13″. 2 parts. 2*s*. 3*d*. each.

Comprehensive statistics of staff employed under the Government of West Bengal (as on 31st May 1952). Calcutta, 1953. 200p. 13¼″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

II.—AUTHORS AND MISCELLANEOUS

Anderson (Oskar). Probleme der statistischen Methodenlehre in den Sozialwissenschaften. Würzburg, Physica-Verlag, 1954. [ii] 345p. 9″. *DM.* 13.80. (Einzelschr. Dtsch. Statist. Ges. 6)

Armitage (P.). Effect of nitrogen mustard on an inherited character in the rat. *Nature* (1953), **171**. p. 1117. [2p] 8¾″.

A note on the epidemology of malaria. *Trp. Dis. Bull.* (1953). 890–2. 8¾″.

Armitage (P.) & Mollison (P. L.). Further analysis of controlled trials of treatment of haemolytic disease of the newborn. *J. Obstet. Gynaec., Brit. Emp.* (1953), **60**, 605–20. 9¾″.

Bass (J.). Space and time correlations in a turbulent fluid. Part I. Berkeley, *Univ. California Publ. Statist.* (1954), **2**, 55–84. 10¼″. 50*c.*

Bell (D. A.). Statistical methods in electrical engineering. London, Chapman & Hall, 1953. viii, 175p. 8½″ 25*s.*

Bellamy (Dennis). The development of the domestic load at home and overseas. London, The Convention Council, 1954. (6th British Electrical Power Convention, Eastbourne.) 60p. 8½″.

Bennett (Carl A.) & Franklin (Norman L.). Statistical analysis in chemistry and the chemical industry ... sponsored by the Committee on Applied Mathematical Statistics, The National Research Council. New York, Wiley, 1954. (London, Chapman & Hall). xvi, 724p. 9″. 58*s.*

Blackwell (David) & Girshik (M. A.). Theory of games and statistical decisions. New York, Wiley, 1954. (London, Chapman & Hall). xi, 355p. 9″. 60*s.*

Bliss (C. I.). Diuretic agents: II. Estimation of the error in a clinical assay. *Biometrics* (1952), **8**, 237–46. 9¼″.

Insecticidal assays. *Reprinted from* Statistics and Mathematics in Biology; edited by O. Kempthorne & others. 1954. p.345–60. 9″.

The role of a biometrician in the pharmaceutical industry. Quality Control Conference Papers, 1953. p.659–670. 9¼″.

Bliss (C. I.) & Calhoun (D.). An outline of biometry. New Haven, Conn., Yale Co-operative Corporation, 1954. [x], 272, [34] numb. l. 11″.

Bliss (C. I.) & Fisher (R. A.). Fitting the negative binomial distribution to biological data; C. I. Bliss ... Note on the efficient fitting of the negative binomial; R. A. Fisher. *Biometrics* (1953), **9**, 176–200. 9¼″.

Bliss (C. I.) *and others.* A comparison of scoring methods for taste tests with mealiness of potatoes ... *Food Techn.* (1953), **7**, 491–95. 11¼″.

Estimating the dose of a cardiac glycoside for human subjects. *J. Pharmacol.* (1953), **109**, 116–22. 10″.

Blum (Julius R.). Approximation methods which converge with probability one. *Ann. Math. Statist.* (1954), **25**, 382–86. 10″.

Campbell (W. A. B.) & Cheeseman (E. A.). Some aspects of breast-feeding in Belfast. *Brit. J Prev. Soc. Med.* (1954), **8**, 51–58. 9¾″.

Cambridge University. Department of Applied Economics. The way the money went; R. Stone. *Times*, 25, 26 Feb. 1954. 6p. 9½″. (Repr. Ser. 79.)

Recent developments in national income and social accounting; M. Gilbert and R. Stone. *Accounting Res.* (1954), **5**, 1–31. 9¾″. (Repr. Ser. 80)

Chiang (Chin Long). Competition and other interactions between species. *Reprinted from* Statistics and Mathematics in Biology; edited by O. Kempthorne and others. 1954. p.197–215. 9″.

Church (B. M.), Jacob (F. H.) & Thompson (Harry V.). Surveys of rabbit damage to wheat in England and Wales, 1950–52. *Plant Pathology.* (1953), **2**, 107–112. 9¾″

Crawford (J. G.) *and others.* Wartime agriculture in Australia and New Zealand, 1939–50. Stanford, Calif., Stanford Univ. Press, 1954. (London, Geoffrey Cumberlege). xiii, 354p. 9″. $7.50.

Cruickshank (E. M.) & Kodicek (E.). Vitamin D balance and distribution in rats given a massive dose of ergocalciferol Part I. Experimental results. *Biochem. J.* (1953), **54**, 337–47. 10″.

Davies (Owen L.), *editor.* The design and analysis of industrial experiments. London & Edinburgh, Oliver & Boyd, 1954. xiii, 637p. 9¾″. 63*s.*

Davis (M. E.). The use of electronic data processing systems in the life insurance business Presented at the Dec. 1953 Eastern Joint Computer Conference. 14p. 11″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Daw (R. H.). Some statistical aspects of mortality from degenerative heart disease. *J. Inst. Actu.* (1954), **80**, 69–100. $8\frac{3}{4}''$.

Doll (Richard) & Hill (A. Bradford). The mortality of doctors in relation to their smoking habits a preliminary report. *Brit. Med. J.* (1954), **1**, 1451. 13p. $8\frac{1}{2}''$.
Smoking and cancer. *Brit. Med. J.* (1954), **2**, 240. 2p. $8\frac{1}{2}''$.

Dyke (G. V.) & Avis (P. R. D.). A survey of maincrop potatoes I. Estimates of yield, 1948–50. *J. Agric. Sci.* (1953), **43**, 450–55. $10\frac{1}{4}''$.

Ehrenberg (A. S. C.). Notes on Plank's rational method of grading food quality. *Food Tech. Lond.* (1953), **6**, 188. $11\frac{1}{4}''$.

Ehrenberg (A. S. C.) & Shewan (J. M.). The objective approach to sensory tests of food. *J. Sci. Fd. Agric.* (1953), **10**, 482–90. $11''$.

Ellinger (P.) & Armitage (P.). The inheritance in the rat of the capacity to eliminate nicotinamide methochloride. *Biochem. J.* (1953), **53**, 588–96. $10''$.

Enrick (Norbert L.). Quality control a manual of quality control procedure based upon scientific principles and simplified for practical application in various types of manufacturing plants. 2nd. ed. New York, Industrial Press, 1954. (Brighton, Eng., Machinery Publishing Co.). [ix], 181p. $9''$. 37*s*. 6*d*.

Festinger (Leon) & Katz (Daniel), *editors.* Research methods in the behavioral sciences. London, Staples Press, 1954. xi, 660p. $8''$. 50*s*.

Fisher (Sir Ronald). The analysis of variance with various binomial transformations. *Biometrics.* (1954), **10**, 130–39. $9\frac{1}{4}''$.

Fox (L.). A short table for Bessel functions of integer orders and large arguments; prepared on behalf of the Mathematical Tables Committee of the Royal Society by L. Fox. Cambridge Univ. Press, 1954. 28p. $11''$. 6*s*. 6*d*. (Royal Society Shorter Mathematical Tables 3.)

Gnedenko (B. V.) & Kolmogorov (A. N.). Limit distribution for sums of independent random variables ... translated from the Russian and annotated by K. L. Chung ... with an appendix by J. L. Doob ... Cambridge, Mass., Addison-Wesley Publishing Co., 1954. ix, 264p. $9''$. $7.50.

Greiner (Theodore) *and others.* Bioassay of diuretic agents in patients with congestive failure. *J. Pharmacol.* (1951), **103**, 431–40. $10''$.

Hansen (Morris H.), Hurwitz (William N.) & Madow (William G.). Sample survey methods and theory Volume I. Methods and applications. Volume II. Theory. New York, Wiley, 1953. (London, Chapman & Hall). 2 vols. $9''$. Vol. I, 64*s*. Vol. II 56*s*.

Healy (M. J. R.). A method for comparing fly-repellant sprays. *Biometrics* (1953), **9**, 290–94. $9\frac{3}{4}''$.

Hoel (Paul G.). Introduction to mathematical statistics ... 2nd. ed. New York, Wiley, 1954 (London, Chapman & Hall). xi, 331p. $9''$. 40*s*.

Huff (Darrell). How to lie with statistics. London, Gollancz, 1954. 142p. illus. $7\frac{3}{4}''$. 10*s*. 6*d*.

Ingram (G. I. C.), Foxwell (A. W. H.) & Armitage (P.). The nature of the dose-response curve in penicillin plate assay. *Antibiotics Chemotherapy* (1953), **3**, 1217–57. $9\frac{1}{2}''$.

Jensen (Arne). A distribution model applicable to economics. Copenhagen, Munksgaard, 1954. 99p. $10''$.

Jones (Lawrence A.) & Durand (David). Mortgage lending experience in Agriculture. Princeton Univ. Press, 1954. xxii, 234p. $9''$. $5. (Nat. Bur. of Economic Research. Studies in Agricultural Finance, 1.)

Kempthorne (Oscar) *and others.* Statistics and mathematics in biology; edited by O. Kempthorne ... T. A. Bancroft ... J. W. Owen ... J. L. Lush ... Ames, Iowa, Iowa State College Press, 1954. ix, 632p. $9''$. $6.75.

Kline (Morris). Mathematics in western culture. London, Allen & Unwin, 1954. xii, iv, 84p. $8\frac{1}{2}''$. 30*s*.

Kuczynski (Jürgen). Die Geschichte der Lage der Arbeiter in Deutschland von 1789 bis in die Gegenwart. Band I, Erster Teil, 1789 bis 1870. Band I, Zweiter Teil 1871 bis 1932. 6th. ed. Berlin, Tribune, 1954. 343p. $8\frac{1}{2}''$.

Leibenstein (Harvey). A theory of economic-demographic development ... Princeton Univ. Press, 1954 (London, Geoffrey Cumberlege). xi, [ii], 204p. $9''$. 32*s*.

London School of Economics. Division of Research Techniques. An experimental study of quota sampling; by C. A. Moser & A. Stuart ... *J. R. Statist. Soc.* A (1953), **116**, 349–405. $9\frac{3}{4}''$. (Repr. Ser. 24.)
Moments of the rank correlation coefficient tau in the general case; and, A method of systematic sampling based on order properties; by R. M. Sundrum ... *Biometrika* (1953), **40**, 409–420, 452–456. $10''$. (Repr. Ser. 25.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A note on regression when there is extraneous information about one of the coefficients; J. Durbin ... *J. Amer. Statist. Assoc.* (1953), **48**, 799–808. 9½″. (Repr. Ser. 26.)

The power of Wilcoxon's two-sample test; by R. M. Sundrum ... *J. R. Statist. Soc.* B (1953), **15**, 246–252. 9¾″. (Repr. Ser. 27.)

Some results in sampling theory when the units are selected with unequal probabilities; J. Durbin. *J. R. Statist. Soc.* B (1953), **15**, 262–269. 9¾″. (Repr. Ser. 28.)

On Lehmann's two-sample test; by R. M. Sundrum ... *Ann. Math. Statist.* (1954), **25**, 139–145. 9¾″. (Repr. Ser. 29.)

Too good to be true? Alan Stuart ... *Appl. Statist.* (1954), **3**, 29–32. 9¾″. (Repr. Ser. 30.)

Lovell (R. R.) *and others.* The effects of cortisone and adrenocorticotrophic hormone on experimental inflammations in the human skin. *Clinical Science* (1953), **12**, 41–55. 9¾″.

Mack (Ruth P.). Factors influencing consumption: an experimental analysis of shoe buying. New York, National Bureau of Economic Research, 1954. [viii], 124p. 10¾″. $2. (N.B.E.R. Tech. Papr. 10.)

Medical Research Council and Nuffield Foundation. Joint Committee. A comparison of cortisone and aspirin in the treatment of early cases of rheumatoid arthritis; a report by the Joint Committee of the Medical Research Council and Nuffield Foundation on clinical trials of cortisone, A.C.T.H., and other therapeutic measures in chronic rheumatic diseases. *Brit. Med. J.* (1954), **1**, 1223. 8½″.

Miller (J. C. P.), *editor.* Table of binomial coefficients: prepared for the Mathematical Tables Committee of the British Association and the Royal Society ... Cambridge University Press, 1954. viii, 162p. 11″. 35*s.* (Royal Society Mathematical Tables Vol. 3.)

Miani Calabrese (Donato). Vincenzo Castrilli. *Studi Senesi* (1952), **64**, 524–546. 9¾″.

Morgan (Max E.) *and others.* An improved procedure for microscopic grading of milk intended for pasteurization. *J. Milk Tech.* (1952), **15**, 3–7. 11″.

A sequential procedure for grading milk by microscopic counts. Storrs, Conn., Storrs Agricultural Experiment Station, 1951. 35p. 9″. (Bulletin 276.)

National Institute of Economic and Social Research. Some problems of inter-plant cost comparisons; by W. F. Luttrell. *Accounting Res.* (1954), **5**, 1–14. 9¾″. (Repr. Ser. 2.)

Netherlands. Centraal Planbureau. Wie voorspelt het best; H. Theil. *De Economist* (1954), **102**, 12p. 9½″. (Repr. Ser. 20.)

Enkele beschouwingen over het monetair overzicht; H. W. J. Bosman. *Maandschrift Economie* (1954), 19p. 9½″. (Repr. Ser. 30.)

Econometric models and welfare maximisation; H. Theil ... *Weltwirtschaftliches Arch.* (1954), **72**, 60–83. 9″. (Repr. Ser. 31.)

Die Anwendung des Nationalbudgets zur Beurteilung der Wahrungslage; J. Tinbergen und D. B. J. Schouten. *Wirtschafsdienst* (1954), **34**, 19p. 9½″. (Repr. Ser. 32.)

De afneming van het vrouwenoverschot in Nederland; door Ed. van Cleeff en A. I. V. Massizzo. *Econ. Stat. Berichten.* **39**, 7p. 9½″. (Repr. Ser. 33.)

Het vraagstuk "Belastingen of leningen" in de huidige Nederlandse situatie; H. W. K. Bosman. *Katholiek Staat Kundig Maandschrift* (1954), **8**, 144–157. 9½″. (Repr. Ser. 34.)

Neyman (Jerzy). Philosophical analysis of "objective" probability in science. *Nature* (1954), **173**, 603. [3p] 8¼″.

Rao (A. V. Raman). Structure and working of village Panchayats: a survey based on case studies in Bombay and Madras; [Poona], Gokhale Institute of Politics and Economics. 1954. xvi, 218p. 9¾″. 11*s.* (Publication, 28.)

Rau (A. Ananthapadmanabha). Crop surveys in Mysore state (1952–1953). Bangalore, Section of Statistics, 1953. 26p. 9¾″. (Bulletin 3. 1953.)

Reserve Bank of India. Banking and monetary statistics of India. Bombay, 1954. xiv, 1005p. 11″. *Rs.* 35.

Robbins (Lionel). The economist in the twentieth century, and other lectures on political economy. London, Macmillan, 1954. xi, 225p. 8½″. 16*s.*

Rosenberg (Louis). A study of the changes in the geographic distribution of the Jewish population in the metropolitan area of Toronto, 1851–1951. Montreal, Canadian Jewish Congress, 1954. ii, 27 l. 11″. (Canadian Jewish Population Studies. Jewish Community Series 2.)

Ruben (H.). On the moments of order statistics in samples from normal populations. *Biometrika* (1954), **41**, 200–227. 10¾″.

Sant'Ambrogio (Luigi). Dispersione dei prezzi relativi. *Studi e Statistiche Milan.* (1953) 49p. 11″.

Scheffe (Henry). Statistical methods for evaluation of several sets of constants and several sources of variability. *Chem. Engn. Progress* (1954), **50**, 200–205. 11¼″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Schmid (Calvin F.). Handbook of graphic presentation. New York. The Ronald Press, 1954. vii, 316p. 9″. $6.

Scott (E. L.) *and others*. Comparisons of synthetic and actual distribution of galaxies on a photographic plate. *Astrophys. J.* (1954), **119**, 91–112. 9½″.

Shenton (L. R.). Efficiency of the method of moments and the Gram-Charlier type A distribution. *Biometrika* (1951), **38**, 58–73. 10¾″.

Inequalities for the normal integral including a new continued fraction. *Biometrika* (1954), **41**, 177–189. 10¾″.

Maximum likelihood and the efficiency of the method of moments. *Biometrika* (1950), **37**, 111–116. 10¾″.

On the efficiency of the method of moments and Neyman's type A distribution. *Biometrika* (1949), **36**, 450–454. 10¾″.

Shewan (J. M.) *and others*. The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice. *J. Sci. Fd. Agric.* (1953), **6**, 283–298. 11″.

Silverman (Rodney). Advertising expenditure 1952. [London], The Advertising Association, [1954], xi, 64p. 9¾″. 21*s*.

Stevenson (A. C.). Recording genetic information concerning individuals and families. *Ulster Med. J.* (1954), **23**, 54–60. 9½″.

Swerling (Boris C.). California agriculture and international commodity developments. San Francisco, Federal Reserve Bank. *Monthly Rev. Supplement.* (1954), January. 21p. 10½″

Tinley (J. M.). South African food and agriculture in world war II. Stanford, Calif., Univ. Press, 1954 (London, Geoffrey Cumberlege). xii, 138p. 9″. $5.

Turner (Neely) & Bliss (C. I.). Tests of synergism between nicotine and the pyrethrins. *Ann. Appl. Biol.* (1953), **40**, 79–90. 10″.

Vand (Vladimir) & Pepinsky (Ray). The statistical approach to X-ray structure analysis. Pennsylvania State University, Dept. of Physics, 1953. xvi, 98p. 11″.

Ventura (Ovidio S.). Tendencias y estructura de la poblaçion Argentina. Buenos Aires, 1953. 67p. 10½″.

Whelpton (Pascal K.). Cohort fertility: native white woman in the United States. Princeton, N.J., Princeton Univ. Press, 1954. (London, Geoffrey Cumberlege.) xxvii, 492p. 10″. 48*s*.

Working (Holbrook). Whose markets? evidence on some aspects of futures trading. *J. Marketing* (1954), **19**, 1–11. 10″.

Yates (Frank). Crop prediction in England. *Bull. Int. Statist. Inst.* (1951), **23**, II. 295–312. 9¾″.

Zagoroff (S. D.). The concept of energy in economics. *Weltwirtschaftliches Arch.* (1954), **72**, 84–101. 9½″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

110635
Digitized by Arya Samaj Foundation Chennai and eGangotri

REVENUE OF THE UNITED KINGDOM

Net Produce in Quarters of 1953, *and the Financial Years ended March* 31, 1952-53, 1951-52, 1950-51, 1949-50

(000's omitted)

	Quarters ended				Total for Calendar Year 1953
	March 31, 1953	June 30, 1953	Sept. 30, 1953	Dec. 31, 1953	
	£	£	£	£	£
Inland Revenue—					
Income Tax	1,080,383	238,886	211,302	193,564	1,724,135
Surtax	80,200	21,100	12,000	16,900	130,200
Death duties	40,700	45,200	35,400	41,200	162,500
Stamps	13,000	13,400	12,700	15,500	54,600
Profits tax and excess profits tax	81,000	43,100	57,900	43,800	225,800
Excess profits levy	2,850	9,850	23,200	15,000	50,900
Special contribution and other Inland Revenue duties	710	330	190	250	1,480
Total Inland Revenue	1,298,843	371,866	352,692	326,214	2,349,615
Customs	250,356	259,021	268,009	270,650	1,048,036
Excise	189,992	176,687	181,071	190,997	738,747
Total Customs and Excise	440,348	435,708	449,080	461,647	1,786,783
Motor vehicle duties	51,463	7,346	6,152	4,983	69,944
Surplus receipts from certain trading services	—	—	—	—	—
Post Office (net receipts)	1,200	—	—	3,800	5,000
Broadcasting receiving licences	5,200	3,000	2,850	5,050	16,100
Receipts from sundry loans	4,632	2,015	17,332	963	24,942
Miscellaneous receipts (including sale of surplus war stores)	26,188	25,406	39,333	30,904	121,831
Total Ordinary Revenue	1,827,874	845,341	867,439	833,561	4,374,215
Self balancing Revenue—					
Post Office	56,800	50,400	55,900	58,700	221,800
Income tax deducted from excess profits tax, post-war refunds	1,313	1,248	958	3,093	6,612

	Year 1952/53	Year 1951/52	1952/53 (compared with 1951/52)		Corresponding Years	
			Increase	Decrease	1950/51	1949/50
Inland Revenue—						
Income Tax	1,736,233	1,668,749	67,484	—	1,404,364	1,438,386
Surtax	131,200	129,600	1,600	—	121,100	114,700
Death duties	151,850	183,000	—	31,150	185,250	189,600
Stamps	50,250	61,900	—	11,650	54,460	51,470
Profits tax and excess profits tax	376,100	315,400	60,700	—	267,770	296,960
Excess profits levy	2,950	—	2,950	—	—	—
Special contribution and other Inland Revenue duties	2,020	3,270	—	1,250	5,445	20,238
Total Inland Revenue	2,450,603	2,361,919	88,684	—	2,038,389	2,111,354
Customs	1,024,498	998,497	26,001	—	905,216	813,334
Excise	739,093	753,285	—	14,192	724,800	706,400
Total Customs and Excise	1,763,591	1,751,782	11,809	—	1,630,016	1,519,734
Motor vehicle duties	67,658	65,211	2,447	—	61,357	55,772
Surplus receipts from certain trading services	—	75,455	—	75,455	80,905	47,541
Post Office (net receipts)	—	—	—	—	962	—
Broadcasting receiving licenses	14,800	14,150	650	—	13,000	12,600
Receipts from sundry loans	24,681	25,393	—	712	26,876	20,244
Miscellaneous receipts (including sale of surplus war stores)	117,382	139,482	—	22,100	126,319	156,786
Total Ordinary Revenue	4,438,715	4,433,392	5,323	—	3,977,824	3,924,031
Self-balancing Revenue—						
Post Office	209,900	190,050	19,850	—	171,088	162,100
Income tax deducted from excess profits tax, post-war refunds	5,192	5,525	—	333	8,347	11,895

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

INDEX TO VOL. 117.

YEAR 1954

(Statistical and Current Notes are indicated by the letters S.N. and C.N. respectively.)

PAGE

ADDITIONS to the Library. *See* LIBRARY.
AGRICULTURAL productivity in the principal countries. *See* CLARK (COLIN).
ALLEN (R. G. D.). Created C.B.E., 1954 120
ANNUAL General Meeting, 1954 . . 481

BANK OF ENGLAND, Weekly return, 1953 . 260
BAUER (P. T.). Statistics of statutory marketing in West Africa, 1939–51 . . 1–20
- The marketing boards and their operations: cocoa, groundnuts, palm-oil kernels, cotton 1–6
- Effects on producers of statutory marketing . 6–14
- Producers' terms of trade (in terms of cotton piece-goods imports) . . 14–16
- Accumulated surpluses and their effects . 16–17
- *Appendix:* Sources and method of calculation of Tables 17

Discussion: Dr. E. Hallett; Miss P. Deane; Miss P. Ady; Dr. J. R. Raeburn; Dr. A. R. Prest; Professor Milton Friedman; Mr. Bauer in reply . 20–30
BAYES (THOMAS), F.R.S. . . . 120
BENJAMIN (B.). Medicine and medical services in the United Kingdom (Sources and Nature of Information Series) 210–232
- Statistics in medicine 210
- Measurement of morbidity—mortality statistics—infectious disease—older local authority statistics . . . 213–20
- Hospital and specialist services—general medical, dental and ophthalmic services . . 221–25
- Clinical trial—diagnosis—genetics . . 226–27
- *Appendix:* General Register Office; References 227–32

BOOKS. Reviews and notices of statistical and economic books:
- Annual epidemiological and vital statistics, 1950 (W. H. O.) 490
- Bell (D. A.). Statistical methods in electrical engineering 362
- Bickley (W. G.). Bessel functions and formulae 362
- Bowden (B. V.) (ed.). Faster than thought . 106
- Braithwaite (R. B.). Scientific explanation . 233
- British Transport Commission—Bristol on the move 243
- Burns (A. F.). The frontiers of economic knowledge 366
- Cairncross (A. K.). The Scottish economy . 490
- Carrier (N. H.) and Jeffery (J. R.). External migration 238
- Charnes (A.), Cooper (W. W.) and Henderson (A.). An introduction to linear programming 236
- David (F. N.) and Kendall (M. G.). Table of symmetric functions. Part IV . . 362
- Desai (R. C.). Standard of living in India and Pakistan, 1931–2 to 1940–1 . . 117
- Digest of Scottish statistics (S.N.) . . 247
- Economic Commission for Europe. Economic survey of Europe in 1953 (S.N.) . 248
- ——— The European steel market in 1953 (S.N.) 369
- Economic Commission for Europe. Competition between aluminium and steel (S.N.) 369
- ——— (and others). A study of trade between Asia and Europe (S.N.) . . 248
- Fabricant (S.) and Lipsey (R. E.). Trend of Government activity in the U.S. since 1900 494
- Ferber (R.). A study of aggregate consumption functions 364
- Frankel (S. H.). The economic impact on under-developed societies . . . 111
- Fryer (H. C.). Elements of Statistics . . 486
- Gilbert (M.) and Kravis (I. B.). An international comparison of national products and the purchasing power of currencies . 365
- Guides to official sources: Local Government statistics (S.N.) 369
- Hansen (M.), Hurwitz (W.) and Madow (W.). Sample survey methods and theory . . 236
- Huff (D.). How to lie with statistics . . 496
- Hultgren (T.) and Greenwald (W. I.). Transport and the state of trade in Britain . . 486
- International Association for research in income and wealth—Income and Wealth: Series II, ed. by S. Kuznets; Series III ed. by Milton Gilbert 114
- International defunction and measurement of standards and levels of living . . 493
- Irvine (A. G.). Marketing research and management 489
- Jackson (Willis) ed. by. Communication theory 104
- Kendall (M. G.). Exercises in theoretical statistics 237
- Kuhn (H. W.) and Tucker (A. W.) ed. by. Contributions to the theory of games . 103
- Latscha (R.). Tests of significance in a 2×2 contingency table 362
- Lindley (D. V.) and Miller (J. C. P.). Cambridge elementary statistical tables . . 110
- Mills (Frederick C.). Productivity and economic progress 112
- Mothes (J.). Techniques modernes de contrôle des fabrications. Tome I . . 108
- Lengyel (S. J.). International insurance transactions 495
- Lindquist (E. F.). Design and analysis of experiments in psychology and education . 105
- Martin (Anne) and Lewis (J. Parry). Welsh economic statistics 243
- Matthews (R. C. O.). A study in trade cycle history, 1833–42 242
- National Bureau of Standards. Applied mathematics series. Tables of 10 (Anti-logarithms to the base 10): Table of natural logarithms for arguments between zero and five to sixteen decimal places . . . 238
- National Bureau of Standards. Tables of normal probability functions . . . 109
- ——— Probability tables for the analysis of extreme-value data 109
- Newspaper reading by University students (S.N.) 370
- Paradine (C. G.) and Rivett (B. H. P.). Statistics for technologists 107
- Romig (H. G.). 50–100 binomial tables . 237
- Schlote (Werner). British overseas trade from 1700 to the 1930's 240
- Schmidt (C. F.). Handbook of graphic presentation 485
- Silverman (R.). Advertising expenditure, 1952 488
- Smith (C. A. B.). Principles of mathematics for students of biological science . . 361
- Spear (Mary E.). Charting statistics . . 107
- Sterling area, the: An American analysis . 116

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PAGE

Sukhatme (P. V.). Sampling theory of surveys with applications . . . 484
Thomas (Brinley). Migration and economic growth 491
Timber statistics, Year book, 1953 . . 498
Upp[illegible]a Symposium on psychological factor analysis, 1953 482
UNESCO. World list of Social science periodicals (S.N.) 370
Utting (J. E. G.). Social account of local authorities: an experiment in sampling methods 239
Walker (H. M.) and Lev (Joseph). Statistical inference 102
Winkler (Wilhelm). Typenlehre der Demographie 114
Wold (H.). Analysis of stationary time-series 484
Wold (Herman) and Juréen (Lars). Demand analysis 235
Wolfenden (Hugh H.). Population statistics and their compilation . . . 363
Woytinsky (W. S. and G. S.). World population and production . . . 112

BROWNING (H. E.) and SORRELL (A. A.). Cinemas and cinema-going in Great Britain 133–165

I. Introduction—estimates of admissions and gross takings, 1934–52—attendance in principal countries 133
II. Cinemas, seats and programmes . . 136
III. The cinema-going habit—Sunday and special children's performances . . 145
IV. Cinema revenues and costs . . 153
Summary 164

Discussion: Mr. L. T. Wilkins; Mr. Emmett; Miss P. M. Nye; Mr. Mason; the authors in reply . . 165–170

CALLBACKS and clustering in sample surveys. *See* DURBIN (J.) and STUART (A.).
CENSUS, 1951. Note on County Reports so far published 246
CINEMAS and cinema-going in Great Britain. *See* BROWNING (H. E.) and SORRELL (A. A.).
CLARK (COLIN). World supply and requirements of farm products . . . 263–291

Introductory 263
International scales of measurement; international units; oriental units; F.A.O. index numbers . . . . 265 ff.
World agricultural production (Table) . 268
Product per unit of labour engaged . . 271
Consumption, expenditure per head, real income per head, of principal countries (table and graph) 272–3
Analysis of results 274
Trends in real demand for farm products . 278
U.S. agricultural productivity, 1869–1953 . 283
Costs; factor payments; non-factor costs; fertilizers 287

Discussion: Mr. Campion; Professor Dudley Stamp; the Chairman; Mr. W. F. Searle; Mr. J. L. Nicholson; Professor Lewis; Mr. Colin Clark in reply 291–296
CLAY (SIR HENRY). Obituary notice . 500
COUNCIL, Report of, for the financial year ended Dec. 31st, 1953, and the sessional year ended June 23rd, 1954 . 463

DEMAND for motor-cars in the United States. *See* FARRELL (M. J.).
DURBIN (J.) and STUART (A.). Callbacks and clustering in sample surveys . 387–418

PAGE

1. Introduction: methods discussed . . 387
2. Design of the experiment . . . 389
3. Results on non-response . . . 392
4. Results on clustering . . . 400
5. Interviewer variability . . . 407
6. Conclusions 409

Discussion: Mr. J. L. Nicholson; Dr. Nuttall; Mr. P. G. Gray; Mr. H. Henry; Mr. Gregory; Dr. Durant; Dr. Finney; Mr. D. H. Pickard; Mr. A. S. C. Ehrenberg; the authors in reply 418–428

ELECTIONS to Fellowship, 30, 72, 170, 201, 296, 330, 428, 481
EMPLOYED population . . 118, 245, 368, 497
—— age analysis 369
ESSAY on the mathematical theory of freedom. *See* GABOR (DENIS and ANDRÉ).
FARM products. World supply and requirements. *See* CLARK (COLIN).
FARRELL (M. J.). The demand for motor-cars in the United States . . . 171–193

1. *Introduction.*—Problem of consumers' durables; previous analyses of the demand; theoretical model; problems of its application 171–177
2. *Application to cross-section data.*—Budget functions; estimation procedure; results of cross-section analysis . . . 177–182
3. *Application to time-series.*—Theoretical and practical problems of the time-series analysis; construction of price-indices; notes on the other series used . . . 182–189
4. *Prediction of post-war demand.*—Prediction and verification; method of prediction; post-war data 189–193

Discussion: Mr. W. J. Corlett; Mr. G. Morton; Professor Champernowne; Mr. R. F. F. Dawson; Mr. W. F. Harris; Mr. A. G. M. Webster; Mr. Farrell in reply 194–200
FINUCAN (H. M.). The mode of a grouped distribution 459
FREEDOM, mathematical theory of. *See* GABOR (DENIS and ANDRÉ).

GABOR (DENIS and ANDRÉ). An essay on the mathematical theory of freedom . 31–60

I. The statistical concept of freedom; postulates; measures of diversity and independence; statistical freedom and the liberal creed 32–43
II. Mathematical part 43–60

Discussion: Professor Barnard; Professor Champernowne; Dr. I. J. Good; Professor M. G. Kendall; Professor Bartlett; Dr. Vajda; Dr. D. M. MacKay; the authors in reply . . 60–72
GLOVER (K. F.) and MILLER (D. N.). Outlines of the road goods transport industry 297–323

The sample enquiry; organisation; results; summary 297–300
Vehicles; carrying capacity; types of fuel; age 301–2
Operation; commodities carried; mileages; tonnages carried 303–9
Lengths of haul; nature of operations performed by several categories . . 311–15
Appendices: I—Supplementary Tables; II—Licences 318–23

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PAGE

Discussion: Mr. Harris-Burland; Mr. Gresham Cooke; Mr. Ponsonby; Mrs. Cox; Dr. Buckland; Mr. C. T. Saunders; Mr. A. A. Adams; Mr. H. Palca; Dr. F. Garwood; Miss K. Liepmann; Mr. J. A. Bound; Mr. Ernest Rudd; the authors in reply . 324–330
GREBENIK (E.). Appointment to Chair of Social Studies in the University of Leeds 370

HARTLEY (H. O.). Elected a Fellow of the American Statistical Association . 120
HEIGHTS and weights of the army intake. *See* ROSENBAUM (S.).
HILL (Professor A. BRADFORD). Elected to Fellowship of the Royal Society . 120
—— Award of Guy medal in gold . . 469
HONOURS list, New Year, 1954, Fellows included 120
HOUBLON-NORMAN Fund. Awards for 1954–55 248
—— Announcement of awards offered for 1955 499

INDEXES of input, gross output and net output. *See* KARMEL (P. H.).
INTERNATIONAL Conference of National Committees on vital and health statistics, the First 460
INTERNATIONAL Statistical Institute—28th Session, Rome, 1953. Programme; Address by H.H. Pope Pius XII; Message from Professor Luigi Einaudi, President of the Italian Republic . 80–84

KARMEL (P. H.). The relations between chained indexes of input, gross output and net output 441–458
1. Theoretical 441
2. Empirical 447
3. Conclusions 456
KENYA, Tanganyika and Uganda, Census 498

LABOUR turnover, the phenomenon of. *See* SILCOCK (H.).
LEE (DORIS M.). The statistics of education (Sources and Nature of Information Series) 348–360
I. Statistics of educational administration . 349
II. Statistics of educational research . . 356
III. International aspects of educational statistics 358

LIBRARY, Additions to, 1953–54 127, 253, 376, 506
LOMAX (K. S.). Regional economic statistics (Sources and Nature of Information Series) 85–101
Current regional economic surveys; concentrated industries; the nationalized industries 85–87
Agriculture 88
Regional economic statistics in general: demography, labour, employment and unemployment, production, distribution, transport, income, banking 89–98
Comments and conclusions; bibliography . 98–101

MATHEMATICAL Theory of freedom. *See* GABOR (DENIS and ANDRÉ).
MEDICINE and medical services in the United Kingdom. *See* BENJAMIN (B.).
MODE of a grouped distribution. *See* FINUCAN (H. M.).
MORBIDITY statistics. *See* REGISTRAR GENERAL *and under* BENJAMIN (B.).
MOTOR-CARS, demand for in the United States. *See* FARRELL (M. J.).
MUSICIANS, length of life of. *See* RODRIGUES (MILTON DA SILVA).

OBITUARY—
Sir Henry Clay 500
Dr. W. T. Russell 121
A. M. Southall 501
OUTLINES of the goods transport industry. *See* GLOVER (K. F.) and MILLER (D. N.).
OUTPUT and input, indexes of. *See* KARMEL (P. H.).

PAIRING of observations in ordered samples from a normal population. *See under* READ (D. R.).
PHENOMENON of labour turnover. *See* SILCOCK (H.).
PRICES. Retail index numbers, 118, 245, 368, 497
——— wholesale. *See Statist*, Editor of.

READ (D. R.), SMITH (P. G.) and INCE (J. H.). Pairing of observations in ordered samples from a normal population 202–204
REGISTRAR GENERAL. Annual Review—Morbidity Supplement . . . 247
RELATIONS between chained indexes of input, gross output and net output. *See* KARMEL (P. H.).
REVENUE of the United Kingdom . . 512
ROAD goods transport industry. *See* GLOVER (K. F.) and MILLER (D. N.).
RIDLEY (T. M.). O.B.E. . . . 120
ROSENBAUM (S.). Heights and weights of the army intake, 1951 . . . 331–347
Errors of measurement . . . 331
Gains with age and with year of birth . . 333
Frequency distributions . . . 335
Regression of weight and height . . 337
Standard deviations 339
Changes associated with year of birth alone . 342
Standard tables 343
Effect of initial training . . . 346
Summary 346

RODRIGUES (MILTON DA SILVA). Length of life of musicians 73–79
RUSSELL (Dr. W. T.). Obituary notice . 121

SAMPLE surveys, Callbacks and clustering in. *See* DURBIN (J.) and STUART (A.).
SILCOCK (H.). The phenomenon of labour turnover 429–440
Main characteristics—wastage in relation to length of service, skill, sex . . . 429
Annual rate of turnover, considered as analogous to "life table" . . . 431
"Force of separation" 432
Data from individual firms . . . 436
Conclusions 438

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PAGE

SOUTHALL (A. M.). Obituary notice . . 501
Statist, Editor of. Wholesale prices in 1953 205–209

Annual, monthly and quarterly index-numbers, aggregates and groups . . . 205
Average prices of each of the 45 commodities 207
Silver and gold prices and production . . 209

STATISTICAL and economic articles in recent periodicals . . . 122, 249, 371, 502
STATISTICS of Education. *See* LEE (DORIS M.).
STATISTICS, graduate summer sessions in (Southern Education Board, U.S.A.) . 120
STATISTICS in industry, International Year Book 498
STATISTICS of statutory marketing in West Africa. *See* BAUER (P. T.).
TIPPETT (L. H. C.). Award of Guy medal in silver 469
TRADE UNIONS. Membership 119
UNEMPLOYMENT 118, 245, 368, 497
WAGE rates, index of weekly . 118, 245, 368, 497
WEST Africa, Statutory Marketing in. *See* BAUER (P. T.).
WORLD supply and requirements of farm products. *See* CLARK (COLIN).
YUGOSLAV Statistical Society, formation of 120

110635

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

सन्दर्भ ग्रन्थ
REFERENCE BOOK

Compiled
1999-2000

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar